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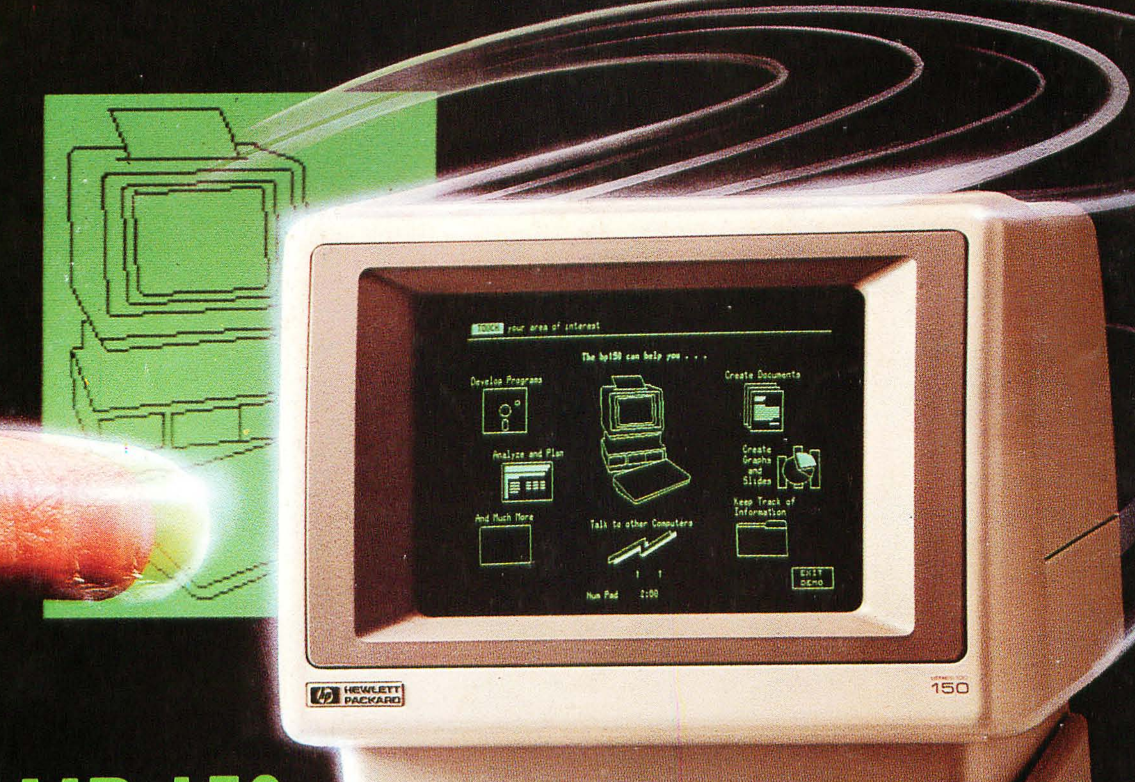


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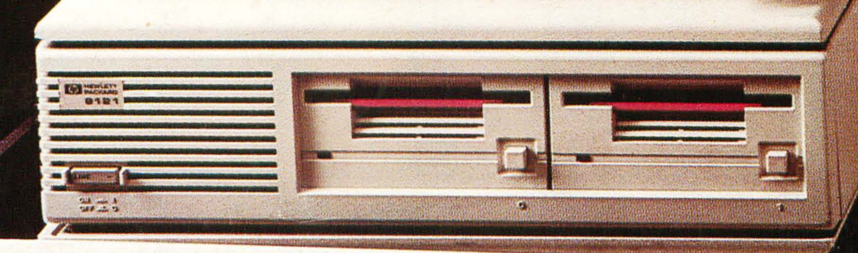
the small systems journal

UNIX ON MICROS



THE HP-150

A Touch of Magic



Computer crime on the increase

NEC's latest advance



Vol. 1, No. 3

Apple's new Monitor II. A sight for sore eyes.

If you've been using a TV as a monitor, perhaps you can get a friend to read this for you:

Apple's brand new Monitor II will improve your vision.

It features all the latest ergonomic improvements in monitor technology.

For example:

Studies have shown that the leading cause of eye fatigue for computer users is lack of contrast between the displayed characters and their background.

So we designed the Monitor II around a high contrast green phosphor CRT that provides an extremely dark background. That means you can read text at a lower brightness. And that means you can be more productive – working longer and more comfortably.

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And we made that screen antireflective to reduce glare from ambient light.

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At your local authorized Apple dealer.

Screen tilts for best working position.

Antireflective screen.

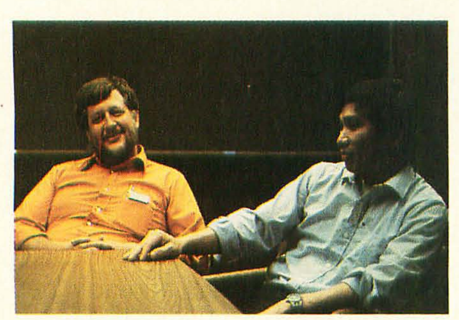
Interior of CRT is etched to reduce glare and improve crispness.

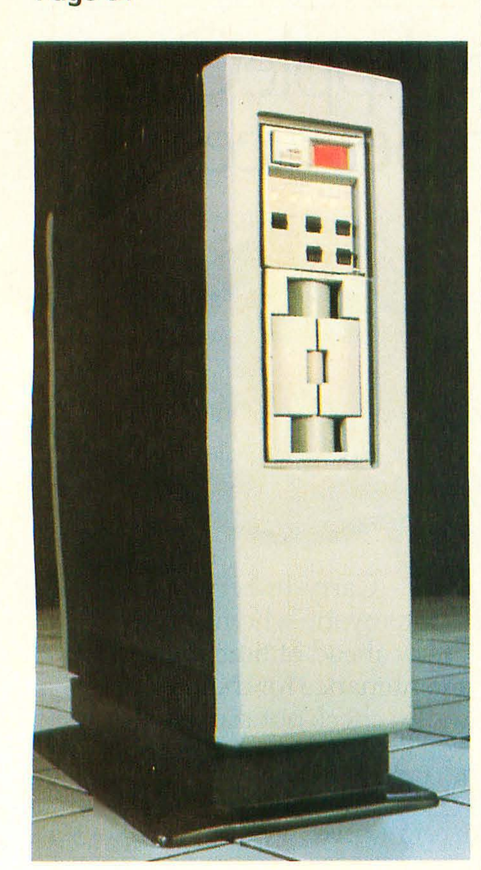
Fits perfectly atop the Apple IIe.

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447 Talker by Heyward S. Williams / Writing a talking program is simple, says the author, if you can use PRINT and INPUT statements to automatically transfer information to a speech synthesizer.

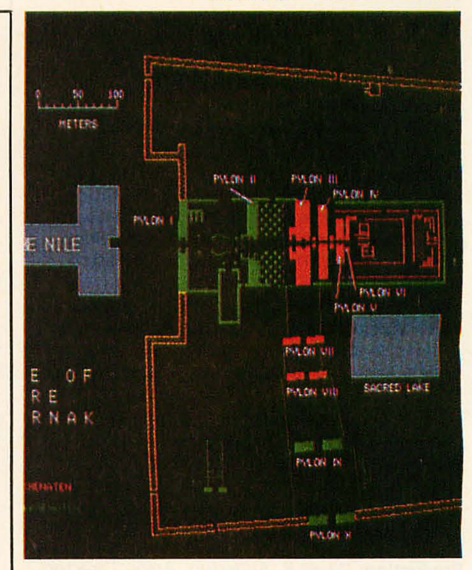
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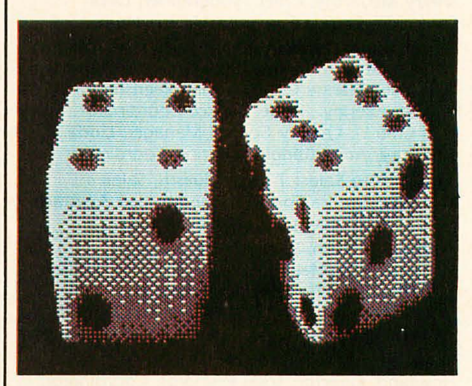
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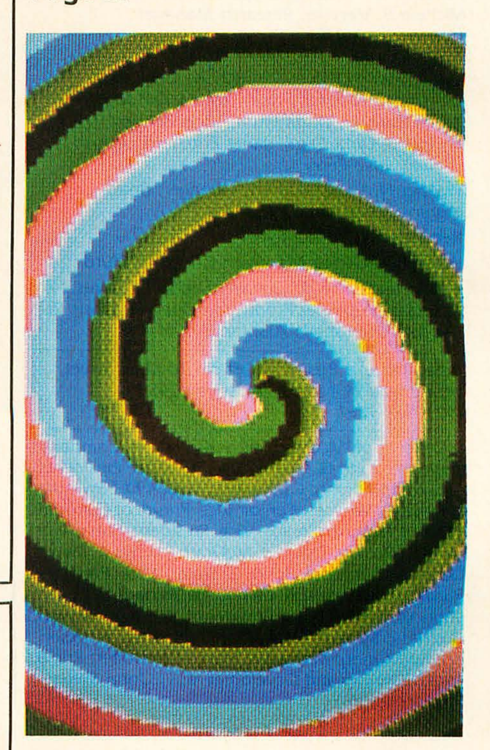
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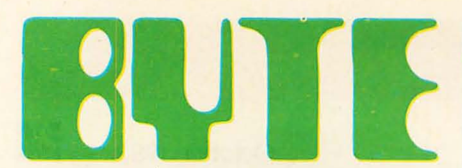


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the small systems journal

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Editorial

A Challenge to Education

Lawrence J. Curran, Editor in Chief

Two months ago, I editorialized about Project Athena, an effort at the Massachusetts Institute of Technology to explore how advanced computers and computer graphics can change the ways in which university students learn (August, page 4). Both Digital Equipment Corporation and IBM Corporation are contributing valuable equipment and services to the project, which is named after the Greek goddess of wisdom. I applauded those companies, along with Apple Computer Inc., for their contributions to education. Apple has donated several million dollars worth of personal computers to more than 9000 public and private schools in California.

Now it's time to applaud Radio Shack for undertaking "America's Educational Challenge," a program intended to introduce computer literacy in the earliest grades possible. The program will help elementary and secondary school teachers to teach students about computers by assisting teachers to become computer literate themselves. Three years ago—even before it formalized this program—Radio Shack took steps to acquaint educators with computers by allowing them free use of equipment in Radio Shack training centers.

In announcing the details of America's Educational Challenge earlier this year, John V. Roach, president and chief executive officer of Tandy Corp., explained why training facilities, located at more than 400 Radio Shack Computer Centers, had been opened to educators. He said educators had repeatedly indicated that they couldn't effectively communicate with students about computers until they themselves became computer literate.

Roach also commented that Radio Shack's efforts grew out of the company's conviction that most Americans under the age of 40 will have to become computer literate in the next decade. We agree, and we commend Tandy/Radio Shack for undertaking America's Educational Challenge. The program enables teachers to take three courses that provide 24 hours of computer training, including an introduction to BASIC, BASIC programming, and a workshop intended to give professional educators an overview of microcomputer applications in the classroom.

In addition to a certificate authorizing free teacher training, Radio Shack has sent the following to more than 103,000 U.S. schools: an educator's handbook describing how microcomputers are used in schools, a basic computer-literacy package designed to teach elementary computer concepts with duplication masters, a secondary-level textbook that illustrates programming concepts, examples of what other school districts are doing with computers, and an order form that enables teachers to sign up for additional computer training.

Radio Shack deserves recognition for sponsoring the program. Of course, it can't help but stimulate sales of Radio Shack computers and software when teachers who have been trained on the equipment decide to purchase their own computers or have an opportunity to influence a school's purchase. But the cost to Radio Shack for only the teacher-training portion of the program could top $10 million if only 2 percent of those being offered the classes took them. That's a substantial investment that carries no clear guarantee that only Radio Shack will benefit from the influence of AEC-trained teachers. ■

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BOTH WORLDS OF PROCESSING
16 bit 8086 IBM compatible software runs under MS-DOS and industry standard 8 bit Z80A software runs under CP/M.

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Staff-written highlights of late developments in the microcomputer industry.

WESTERN ELECTRIC IS FIRST IN U.S. 256K DRAM MARKET

Western Electric, New York, NY, is now selling its 256K-bit dynamic random-access memory (DRAM) chip, which is currently being shipped. Previously, Western Electric had made components only for its own products.

Several other U.S. firms are developing 256K DRAMs for shipment in 1984. Motorola plans to ship samples to companies in the fourth quarter of 1983 and offer production quantities in early 1984, while Intel, Micron Technologies, Texas Instruments, INMOS, and National Semiconductor are expected to begin shipping sample 256K chips during the first half of 1984. While other firms prepare 256K- by 1-bit DRAMs, Mostek, Carrollton, TX, has announced that it will begin shipping samples of a 32K- by 8-bit DRAM this month. Mostek expects that architecture will result in less expensive, less complicated designs but is also working on a 256K- by 1-bit DRAM.

Despite Western Electric's experience in the design of semiconductor products, the other entrants into the 256K DRAM market don't consider it any different from other competitors. One firm projects the sales of 256K DRAMs at several billion units per year by 1988 and is uncertain that any one company can dominate that large a market. Just as significant in the industry are the six Japanese companies reported to be designing or shipping samples of 256K DRAMs: NEC, Oki, Fujitsu, Hitachi, Mitsubishi, and Toshiba. The Japanese have already achieved a dominant market position in 64K DRAMs. In addition, Siemens Corp. is reported to be developing a 256K DRAM in Europe.

Oki Semiconductor says it will ship 10,000 units per month in the U.S. starting this month. Oki expects to ship about 20 percent of all 256K DRAMs worldwide in 1984, or about 600,000 of 3 million units it predicts will be sold.

SHORTAGES AND DELAYS OF COMPONENTS AND MEMORY PLAGUE MICROCOMPUTER COMPANIES

A rapid increase in orders for microcomputer components and memory has led to shortages and delays for some products. The earliest pinch was in 64K-byte RAM chips, but high demand for other components has also led to production delays as suppliers receive unanticipated orders and must either delay shipment or ship partial orders. National Semiconductor, which abandoned its 64K DRAM chip in early 1983 because of production problems, planned to manufacture the Oki Electric 64K DRAM starting in September and hopes to have its own version in production by mid-1984.

Low-power CMOS components, logic circuit chips, and even the popular Z80 microprocessor are becoming hard to get. In late summer, lead times for many versions of these products were 14 to 16 weeks, as compared to less than two weeks in February. New orders for one National Semiconductor logic circuit won't be shipped for at least 30 weeks.

Of several computer manufacturers contacted, most say they haven't been hurt by the pinch, though many agree a problem exists and that it could get worse. Most said they have long-term contracts with suppliers for their needs and speculated that new companies might have more problems.

TELELEARNING CREATES AN ELECTRONIC UNIVERSITY

Telelearning, San Francisco, CA, has announced an Electronic University through its networking system. The company will sell a software and modem package that enables owners of the IBM PC, Apple II, or Commodore 64 with at least one disk drive to access Telelearning's network system. The package will cost from $119 to $200, depending on the computer. Users can then select courses for $50 to $200 each, access course materials, and ask questions of the instructor through the network. Access is through Tymenet, Telenet, and Uninet at no additional charge.

TEXAS INSTRUMENTS AND TIMEX TRY TO BOOST SALES OF LOW-COST COMPUTERS

Texas Instruments, Lubbock, TX, has extended the $50 rebate on its 99/4A computer until January 31, 1984, and extended its warranty to one year. TI will also provide 99/4A buyers with a free five-hour course or a free "Teach Yourself BASIC" cassette. In addition, TI has cut the price of a disk-drive/memory system: the expansion unit, a 32K-byte RAM cartridge, and a disk drive and controller will be combined for a retail price of $550, down from $1200.

In another effort to boost sales, Timex Computer Corp., Waterbury, CT, is giving away a Timex watch to buyers of a Timex/Sinclair TS1000 and a RAM pack. Timex will also offer two free software packages for every two purchased.

WANG ANNOUNCES A HIGH-DENSITY MEMORY MODULE

Wang Laboratories Inc., Lowell, MA, has announced the single in-line memory module (SIMM), a high-density memory package that fits nine 64K-bit RAM chips into a ¾- by 3-inch space on a printed circuit board. Wang hopes to use 256K chips in the SIMM in the future and predicts that the SIMM could fit 1 megabyte of memory in a 3- by 4-inch area using industry-standard mounting practices.

INTERLAN ANNOUNCES A $400-PER-DEVICE ETHERNET LINK

Interlan Inc., Westford, MA, has announced a terminal server to link personal computers and peripherals to Ethernet for as little as $400 per device. Any computer, printer, modem, or other device with an RS-232C (serial) interface can be attached to the NTS-10 terminal server, which links to Ethernet. An eight-port NTS-10 costs $3200, while a four-port version is $2500.

MYSTERY FIRM SIGNS LARGE CONTRACTS WITH IMI, TANDON

Tandon Corp., Chatsworth, CA, has announced a $310 million contract with an unnamed buyer for floppy-disk drives. International Memories Inc. (IMI), Cupertino, CA, also announced a contract with an unnamed firm for more than $100 million worth of 5¼-inch Winchester hard-disk drives. The contracts will probably account for half of each company's business through 1984.

ONYX, SCHUCHARDT, AND MICRORIM UNVEIL INTEGRATED SOFTWARE FOR UNIX, IBM

Onyx Systems, San Jose, CA, has announced what it says is the first integrated software package for the Unix operating system. The Onyx Office includes a user interface "shell" that links word-processing, spreadsheet, database-management, and calendar features. Written in C, the package will be available in mid-October.

Schuchardt Software Systems, San Rafael, CA, has unveiled Intesoft, an integrated software package for the IBM Personal Computer. Based on Intebase, a $495 database-management system, the Intesoft series also includes a $295 spreadsheet, a $149 time planner, a $195 critical-path package, and a $195 interactive application generator for creating other software. Five additional packages, including a word processor, should be available later this year.

Microrim, Bellevue, WA, has unveiled a new database-management package with "gateways" to other popular programs. R:Base can use files generated by Visicorp's Visicalc, Lotus's 1-2-3, Micropro's Wordstar, Microsoft's Multiplan, and Ashton-Tate's dBase II as well as Microrim's own database files. The package is available for the IBM PC for $495 and will soon be available for Unix.

NANOBYTES

Vault Corp., Westlake Village, CA, has introduced a new software-protection system, the Prolok disk. At the time of manufacture, the disk is physically modified with a unique "fingerprint." Programs can be backed up to another disk but won't run without the fingerprint, which can't be copied or erased. . . .**Radio Shack**, Fort Worth, TX, has introduced a 64K version of its TRS-80 Color Computer. The revised system features a typewriter-quality keyboard, a white case, and Extended BASIC for $399.95. Radio Shack is also offering a single-button mechanical mouse for the Color Computer for $49.95. . . .**Sorcim Corp.**, San Jose, CA, has added graphics capabilities to its Supercalc spreadsheet program. Supercalc 3, on one single-sided disk for a 64K IBM PC or Compaq, will cost $395. Sorcim is working on a CP/M version. . . .**Direct Inc.**, Santa Clara, CA, is introducing a $3995 16-bit computer with full mainframe terminal capabilities. The 8088-based 1600 Series includes MS-DOS, a Z80 processor for CP/M-80 applications, and either an HP 2620-compatible or a DEC VT-131-compatible terminal. . . .**CBS Inc.** and **Tandy Corp.** have agreed to grant each other software conversion rights. . . . **Apple Computer**, Cupertino, CA, has introduced a four-pen color plotter for $995. . . .**The Micropro User's Group (MUG)**, Larkspur, CA, has been established for users of Micropro International Corp. software, including Wordstar, Calcstar, and Infostar. . . .**Micropro** is now selling Wordstar for Concurrent CP/M-86. . . .**Visicorp**, San Jose, CA, has introduced Visicalc IV, combining Visicalc with Multisoft Corp.'s $99 Stretchcalc. Adding graphics and sorting features, Visicalc IV for the IBM PC costs $295. . . .**Western Digital Corp.**, Irvine, CA, reports that its Ada compiler for its $20,000 Series 1600 microcomputer has been approved by the U.S. Department of Defense. . . .**North Star Computers**, San Leandro, CA, is offering a "flexible" bundle of software with its Advantage and Horizon computers. Users can choose from among 26 programs—$1100 to $2000 worth of software—offered by North Star. . . .**Morrow Designs**, San Leandro, CA, has introduced the Micro Decision MD-11, a $2745 hard-disk version of its Z80-based MD-1.

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And we test and re-test it ourselves.

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In single-user desk tops, for example, our SuperBrain offers twin Z80s, standard; 64 kbytes of dynamic ram, standard; up to 1.5 mbytes of disk storage, standard; CP/M 2.2* and MBasic,+ standard.

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Why Just Expand When You Can Up-Grade?

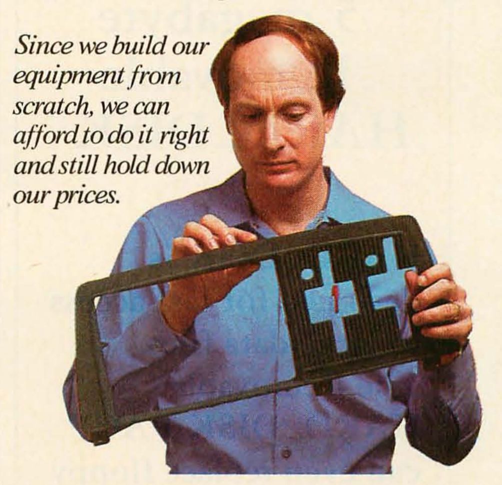
In fact, if you assess your expansion alternatives in terms of relative payback potential, you're very likely to find that up-grading with Intertec equipment from scratch would be more cost-effective than burdening your existing installation with add-on's.

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Letters

Feedback on IBM PC Word Tools

"Word Tools for the IBM Personal Computer" by Richard S. Shuford (May, page 176) has done more to educate me on the subject than any other source I have been able to locate. I just had to write and let you know how much I enjoyed it, even though I am not an IBM PC owner.

In particular, I found his comparison table valuable, and I appreciate the perspective imparted by comparison of the programs (Volkswriter, Easywriter II, Wordstar, and The Final Word) on the basis of what they do (and don't do) well. I'm sitting at the edge of my keyboard waiting to learn the name of the mysterious fifth program, which he used to edit the article.

I noticed a string of features and commands in his comments on The Final Word that appear to be nearly identical to those in Perfect Writer. As examples, the embedded style commands in photo 12 on page 210 appear identical to those in Perfect Writer, and the features described in column 2 of the text on that page also bear striking resemblances. Is there a common origin for these characteristics?

Loren Marshall
1705 Bartlett Dr.
Anchorage, AK 99507

The "mysterious" fifth program was Sorcim Corporation's Superwriter, which I used to write about two-thirds of the text in the review (the other third of the text was written using The Final Word, and I banged out most of the large table on my electric typewriter). We plan to review Superwriter and several other new word-processing programs in future issues.

Both Mark of the Unicorn's The Final Word and Perfect Software's Perfect Writer owe their inspiration to the EMACS text-editing system developed by Dr. Richard Stallman at the Massachusetts Institute of Technology. Perfect Writer and Mark of the Unicorn's MINCE mimic EMACS more closely than does The Final Word. . . . **R.S.S.**

I was very pleased to read the section on "preliminary cautions" in "Word Tools for the IBM Personal Computer" and then choose word-processing software based on those needs. I think reviewers often miss the crucial point that the user's own needs should be analyzed first. I have a few observations from my own experiences with a variety of word-processing programs that some readers may find interesting. (I have never used an IBM PC, but my experiences with CP/M-80 word processors certainly have the same implications for PC owners.)

About a year ago, our company, which specializes in software and turnkey systems for law firms, began installing an extensive multiprocessor CP/M-compatible system in our pilot-site law firm. Word processing is the cornerstone of law-office automation, so we were eager to identify the best possible software for the firm. We looked at Benchmark, Select, and some others but finally found two derivatives of EMACS: Perfect Writer and The Final Word. Perfect Writer, after evaluation, seemed a better choice than The Final Word. One reason was that we didn't like the forward/reverse orientation of The Final Word and preferred Perfect Writer's separate commands for backward and forward operations. In addition, I use Perfect Writer to compose my PL/I source code and find it excellent for this purpose. However, our attempt at implementing it for the law firm was an utter disaster.

A question that word-processing users should ask themselves is: "Am I primarily a text creator/manipulator, or am I a text printer?" I would say that programmers, lawyers, and other professionals are largely text manipulators in that they either do not have a need for perfectly formatted print or they have support staff do their printing for them. Secretaries and other clerical workers are certainly interested in text-creation features, but to them the bottom line is getting that letter, brief, or report to their bosses or in the mail in the proper format at the proper time.

After a few months of using Perfect Writer, this distinction became obvious to us. The embedded formatting-commands approach of Perfect Writer was impossible for a busy law firm in which countless printed documents are produced each day. We found that just one simple formatting-command mistake would ruin the format of an entire document, and even a simple two-page letter required enough of these embedded commands to make at least one mistake likely. It frequently required seven or eight attempts before a document printed correctly. Although we clung to Perfect Writer for a long time, we

eventually relented and installed Wordstar. "What you see is what you get" has proven to be the answer.

I strongly believe that the most important factor in choosing word-processing software is deciding whether text creation or text printing is most important. If the user is a text printer, then by all means go with an "on-screen-formatting" type system and avoid the "embedded-commands" systems like The Final Word and Perfect Writer. Once you have made this distinction, then you can leisurely compare sophisticated features among "on-screen" systems.

Paul W. Stackhouse
Robert Glass & Company
1 Liberty Sq.
Boston, MA 02109

Double-Spacing with Wordstar

I learned a great deal from Richard S. Shuford's lengthy review of word-processing programs for the IBM Personal Computer. As an admirer and a heavy user of Wordstar, I am often amused when I observe that some of the important special features of the program are unknown even by the experts. I learn something new about the program almost every month.

This is a prelude to pointing out an error in your article. You complained that to print out single- and double-spaced versions of the same manuscript you have to reformat all the paragraphs before the second printing. Not true. The dot command controls line spacing. If it is the last dot command used at the beginning of the manuscript, it will not only print any desired line height (in *n*/48ths of an inch), but it will also display page breaks on the screen where they will occur during printing. So you can choose any line height you want, edit on the screen single-spaced, and see the page breaks where they will occur when the manuscript is typed to your specifications. If you want to print two copies of the manuscript with different line spacings, you need only change the single dot command at the beginning of the text and resave. The program will take care of all the rest.

David Gutman
5448 East View Park
Chicago, IL 60615

The method of reformatting for line spacing (for double- or single-spaced text) by the Control-Q, Control-Q, Control-B sequence is not completely satisfactory because extra Return characters must be inserted or removed between the paragraphs for consistent spacing. Reformatting the line spacing by the .LH dot command works if you have one of the daisy-wheel printers supported by Micropro, but Wordstar does not seem to support the feature for some less-common daisy-wheel units and most dot-matrix printers. . . . **R.S.S.**

I enjoyed the review of four word-processing programs. There is a way, however, to change the line spacing in Wordstar other than reforming each paragraph, which I found out by writing to Micropro International. I received this answer: at the beginning of the document, insert these two dot commands that will be interpreted by the Mailmerge routine:

.PF ON
.LS 1 *(or 2)*

The first line turns on print-time formatting; the second line sets the single- or double-spacing.

Bruce J. McLaren
203 Briarwood Dr.
Terre Haute, IN 47803

Acquiring Mailmerge does indeed give you more formatting capability, but the scope of the review was limited to only the four basic software products. In addition to Micropro's Mailmerge and Spellstar, many software products from outside vendors are on the market to add capability to Wordstar. . . . **R.S.S.**

I may be able to help Mr. Shuford with one of his Wordstar difficulties: single-spacing drafts and double-spacing submissions.

Instead of running Wordstar on an IBM PC with an IBM or Epson printer, I'm using a new Morrow Micro Decision with a Star Micronics Gemini-10 printer and running the 8-bit CP/M Wordstar. I understand, however, that the Gemini-10 uses the same control codes and has essentially the same capabilities as the IBM or Epson (except for the Gemini-10's proportional font), so this might work.

When I'm using normal type (10 characters per inch, 65 characters to a line), I always insert

.bp on
.po 0

at the beginning of the text (and see the question mark come up on the first line). Then, before printing, I run a simple Microsoft BASIC program that contains a printer menu. For this form, it effectively does

"LPRINT CHR$(27); "M"; CHR$(10); CHR$(27); "Q"; CHR$(75);"

—telling the *printer* that the left margin is 10 and the right limit is 75. That way, the printer runs full speed and does the work. (It makes a *big* difference in throughput: I'm getting better than 50 cps (characters per second) start-to-finish speed on articles using Wordstar, including waits, formfeeds, and all.)

For the double-spaced submission, you add "CHR$(27); "A"; CHR$(24)" to your LPRINT, and you add these lines at the beginning of your Wordstar document:

.pl 33
.mt 1
.hm 1
.fm 1
.mb 4

These define a shorter Wordstar page with narrower margins, modified slightly to deal with the linefeed you get compliments of the LPRINT statement. That is five lines of typing (of course, you can have it as a text file on the Wordstar disk and copy it in to the document), but it's better than reformatting. I'm inclined to make a single inspection pass through the document before printing to check page breaks. Note that one other thing had to be done, because the original-version Gemini buffer is either loading or printing, never both: change the transmission speed to 9600 bits per second. I've got the serial board—necessary for the Morrow—and it works like a champ at 9600 bps.

Walt Crawford
The Research Libraries Group
Stanford, CA 94305

I don't have a Star Micronics Gemini-10 printer handy, so I tried this with my Epson MX-80 with Graftrax-Plus. Aside from the Epson's lack of a printer command to set the left margin, the double-spacing worked, and the method does print somewhat faster than Wordstar unaided. (Incidentally, the later "X" ver-

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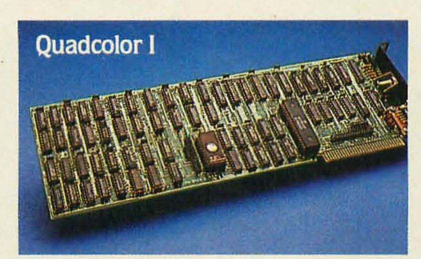
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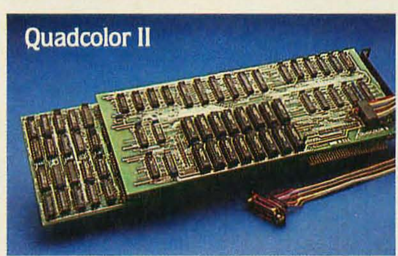
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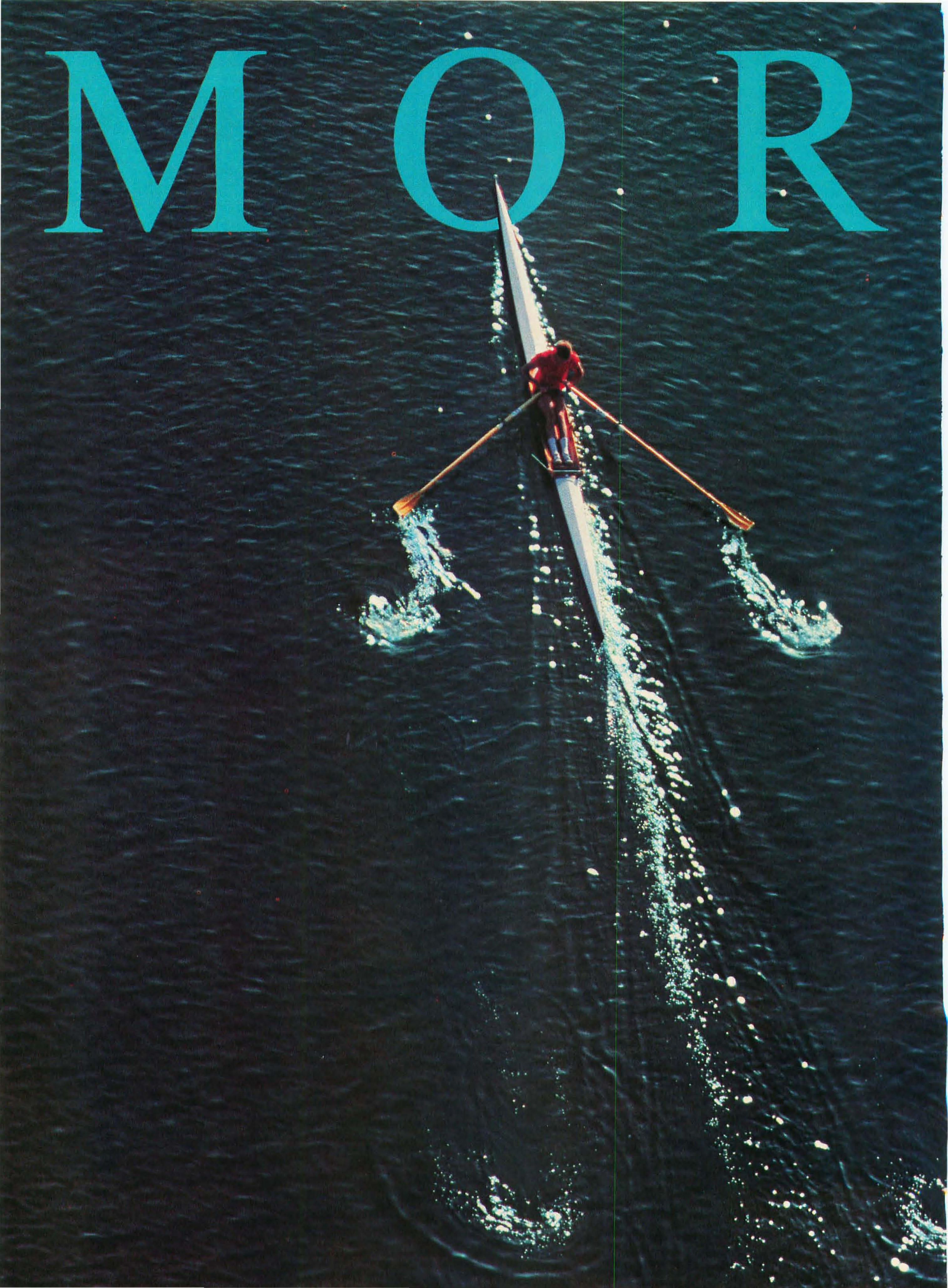
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sions of the Gemini printers are supposed to have remedied the bottleneck of the single-minded character buffer.) . . .
R.S.S.

Searching for the Unsearchable

There was one error in Mr. Shuford's comments that might be significant to people deciding whether to buy Wordstar. He says it "is not possible to use the search functions to locate embedded print-attribute characters. If you want to change all of your underlined text to boldface, you have to search for it the hard way—by eye."

This is true for only three of Wordstar's approximately 20 print-attribute commands: the ones for alternate character width, nonbreak space characters, and underlining. (Their codes, Control-A, -O, and -S, are used in the search functions as wildcard codes to allow searching for ambiguous characters.) Even so, there are ways around this problem.

People using Wordstar with a modern dot-matrix printer will not often have a problem with Control-S because they'd probably rather use an italic font instead of underlining. I have set up Control-R and Control-Q to turn italics on and off.

By the way, it is possible to enter Control-A, -O, and -S in a *replace* string, so a second way to handle the problem is to write the document with another character string substituting for the unsearchable one until the time comes to print, then replace it. This is especially appropriate when printing a draft on a dot-matrix printer and the final copy on a daisy-wheel unit.

A third approach is to surround the unsearchable characters with searchable characters that do nothing. I use Control-D, Control-X, and Control-Y in this way:

↑D↑S↑D
↑X↑O↑X
↑Y↑A↑Y

These guardian characters are ordinarily used as toggles and cancel out after two occurrences. In the search string, I enter:

↑D↑S↑D
↑X↑S↑X
↑Y↑S↑Y

(Here, Control-S has its special wildcard meaning: search for a nonalphabetic or nonnumeric character.) If you've used a double-strike, strikeout, or ribbon-color-change as the printing-attribute character, you'll find it, too. (This should not cause trouble unless you are replacing globally.)

Admittedly, these added key codes are tedious unless you set up a keyboard macroinstruction using a program like Smartkey (from ICI Computers, POB 255, Aurora, CO 97002) under CP/M-80 or Prokey (from Rosesoft, POB 5850, Seattle, WA 98105) under PC-DOS.

The remainder of the 20-odd printing codes can be searched for in the usual manner, but enter them into the search string *as they appear on the screen*, not as you would while typing them into the document. Some control codes are used for cursor movement in the search functions; Control-P must be entered before them—this somewhat obscure requirement is a frequent source of confusion.

One important reason to search for the Control-A and Control-S codes is to make sure that their attributes are eventually turned off, so your printout doesn't go on with page after page of underlining or



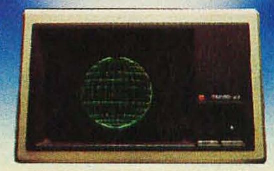
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character spacing. It's a good idea to do this with all print functions that modify more than a single character.

John S. Allen
40 Rugg Rd.
Allston, MA 02134

Mr. Allen has rightly pointed out that most of the attribute characters can be searched; I'm sorry that I did not exhaustively test for searching all the printing-attribute characters. (A minor quibble: in addition to Control-S, -O, and A, Control-N cannot be used in a search string.) However, it seems desirable to have program features work identically for all possible cases. When a feature works in one case and not another, the user will probably be confused and will certainly be burdened with keeping track of what works and what doesn't. He or she will probably disregard the feature. Likewise, for most users, if a feature is poorly documented it might as well not exist.

Several other readers who wrote to inform me about how Wordstar works on 8-bit CP/M-80 systems were not aware of the differences in support and documentation in the 16-bit IBM PC version. Until the recent release of PC-DOS Wordstar version 3.3, many customization features enjoyed by 8-bit users were simply not available to IBM PC users. But aside from slightly better installation options and faster writing of screen displays, version 3.3 is not very different from the Wordstar I tested. . . . **R.S.S.**

TRS-80 Model 16 Problems

We recently purchased a Radio Shack Model 16 microcomputer and upgraded a Model II to a 16. We were faced with the prospect of no software for the Model 16 for over six months. The software promised by Radio Shack has finally arrived and is a version of Xenix. A Microsoft BASIC (TRS-Xenix BASIC) interpreter is also available.

We were especially interested in obtaining what we expected would be a superior performing BASIC interpreter. The 68000 processor would appear to offer a significant performance advantage over the Z80. We have run some simple benchmarks (benchmarks No. 1 and No. 2) to test the speed of the new 68000-based interpreter. Frankly, we're shocked!

Enclosed is a copy of the two benchmarks and timed results for various computers. Because of the poor performance of the TRS-Xenix system, we were concerned about the effective clock speed of the 68000 in the Model 16. We ran another benchmark and found the clock speed of the 68000 to be about 6 MHz, as advertised by Radio Shack. Clearly something is seriously wrong with the TRS-Xenix BASIC and perhaps even with Xenix as it is implemented on the Model 16. We need a faster BASIC interpreter and are hoping some software supplier will help us recover the investment we have made in Radio Shack equipment.

We are not confident, though, that the Model 16 can be improved significantly. We have run two benchmarks on the Model 16, one using TRSDOS-16 with an assembly-language program, and Microsoft BASIC in the Z80 mode. The benchmark echoes the character "1" to the screen 10,000 times. The assembly-language version uses TRSDOS-16 system calls. Shockingly, the BASIC version runs twice as fast. In our opinion, the speed of the Model 16 is totally unacceptable. We

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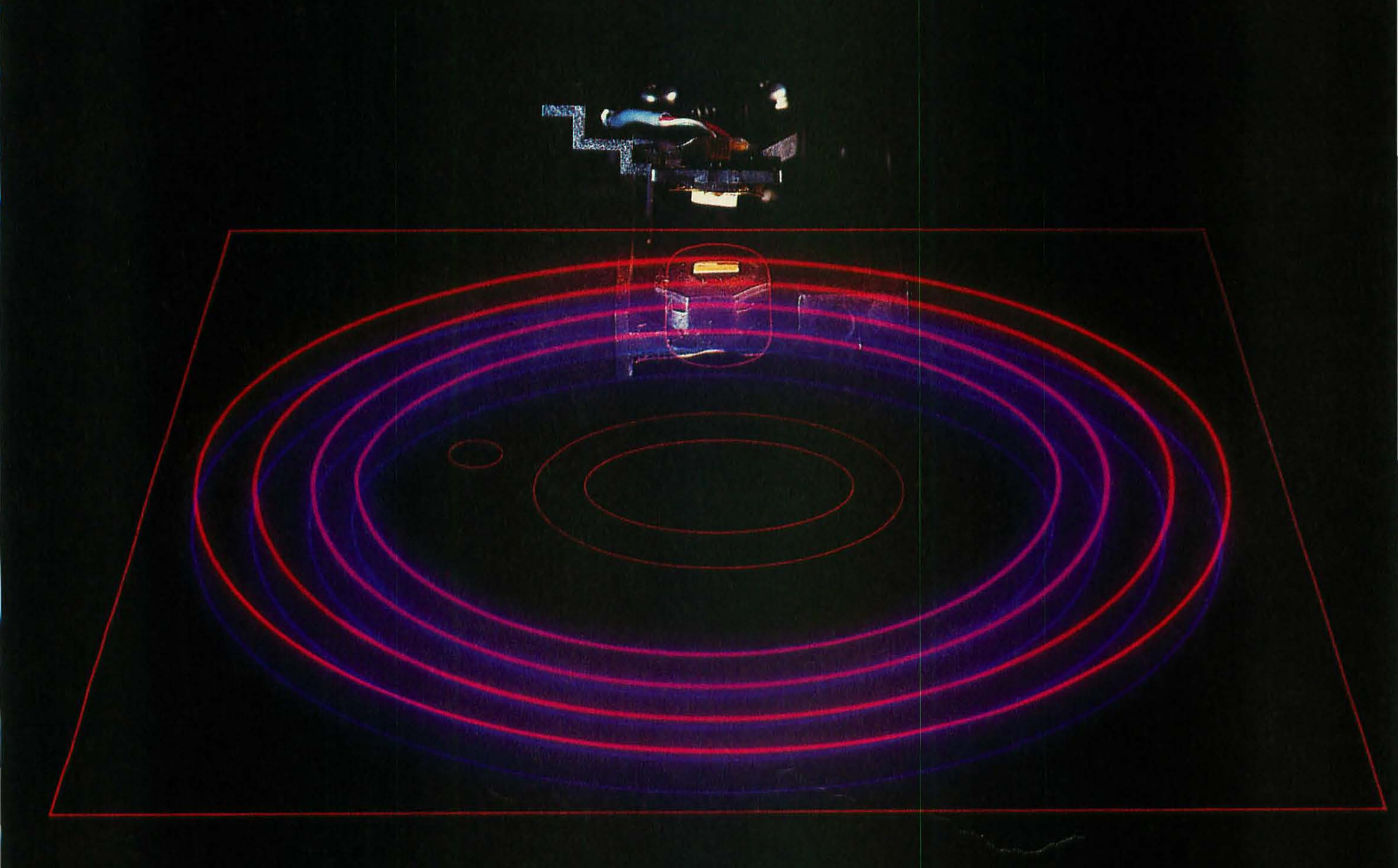
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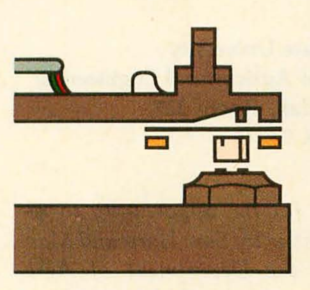
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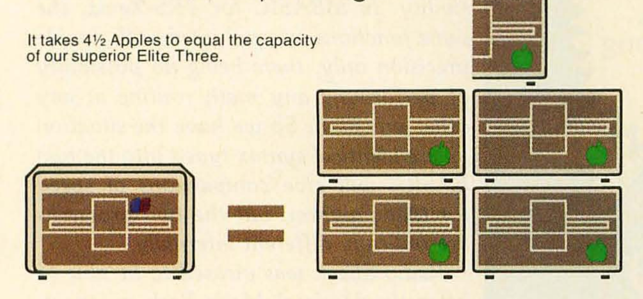
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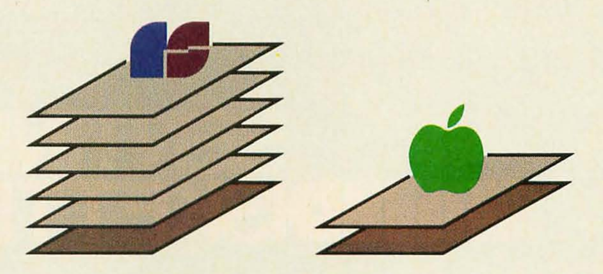
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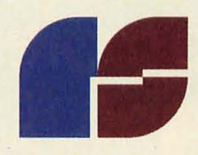
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would welcome any response Radio Shack might be willing to offer on the performance of its Model 16.

Sam Harp
Marvin Stone
Oklahoma State University
Department of Agricultural Engineering
Agricultural Hall, Room 227
Stillwater, OK 74078

Thank you for the opportunity to respond to the letter by Sam Harp and Marvin Stone of the Department of Agricultural Engineering at Oklahoma State University.

We have studied the benchmark tests as submitted by OSU, and we do not substantially disagree with the timings of the tests for the TRS-80. The tests appear to make a Model II running a BASIC program under TRSDOS a faster machine than a Model 16 running TRSDOS-16 or a Model 16 running TRS-Xenix.

As with all benchmark tests, it is appropriate to say that the particular program used has much to do with the timed results. Benchmark #1 is a straightforward BASIC program that evaluates the sine of an expression containing one numeric variable raised to the power of a second variable and repeats this 1000 times. In Model II BASIC, both the exponentiation and the SIN function are evaluated with single precision only, there being no other possibility. In MBASIC for TRS-Xenix, the same functions are evaluated with double precision only, there being no possibility of performing any math routine at any other precision. So we have the situation where identical syntax typed into the two BASICs will give comparisons of speed for that program, but the two programs are radically different internally.

Radio Shack was pleased to be able to offer the Decimal Math Pack as an integral part of TRS-Xenix MBASIC. This removes the "rounding errors" that are an inevitable part of Model II BASIC; of course, this newfound "accuracy" has been at the expense of the speed of some functions, particularly trigonometric functions such as SIN. The BCD (binary-coded decimal) math routines are one of the many ways in which we believe we have been able to provide a superior performing BASIC. But this does not mean that all math is slower because it is in double precision; in fact, a minor variation of the OSU benchmark (using any of the four standard arithmetic operators instead of exponentiation and the SIN function)

will run faster on Xenix than on the Model II.

Program mixes containing a substantial proportion of trigonometry will run slower than a program containing little or no trigonometry in either BASIC, and this time differential will be greater on MBASIC than on Model II BASIC. OSU's Solar Energy Benchmark program contains a substantial proportion of trigonometric functions.

Philip S. Hurrell
Radio Shack Computer Customer Service
400 Atrium-One Tandy Center
Fort Worth, TX 76102

Program

```
230 '*** MODEL 16 (TRS-XENIX).....132.0
240 A=3.14159
250 B=3/7
260 FOR I=1 to 1000
270 Z=SIN(A-B)
280 NEXT I
```

Table 1:

BENCHMARK #1 EXECUTION TIME	SECONDS
IBM PC (MS-DOS)	29.0
OSBORNE (CP/M)	43.0
MODEL II (TRSDOS)	43.0
APPLE II	75.0

Table 2:

BENCHMARK #2 EXECUTION TIME	SECONDS
IBM PC (PC-DOS)	358
OSBORNE (CP/M)	379
MODEL II (TRSDOS)	429
MODEL 16 (TRS-XENIX) ONE USER	677
MODEL 16 (TRS-XENIX) TWO USERS	1316

Editor's note: *the program for Benchmark 2 is an average BASIC program of 130 lines; due to lack of space, it is not included here. . . .* **G.W.**

Commodore 64 Comments

I must comment on several points raised in your review of the Commodore 64 (July, page 232).

First, I don't know what the obsession is with repeating keys. If you want *all* keys to repeat, then a POKE 650, 128 will do the trick. A POKE 650, 0 will cause only the normal keys to repeat.

Second, it is true that you can enter most keywords with two keys (usually the first letter and the shifted second letter). However, only the screen editor shows this coded form—any listed program prints the full word. When working with the screen editor, switching to the upper/lower character set (press the Commodore and shift keys at the same time) will figure the code in a more readable form. For example, POKE 650, 0 would appear as "pO 650, 0". I use this feature quite often for the PRINT# keyword ("pR"). This saves typing the word PRINT and the shifted 3 for the # character.

Third, the disk is awkward in some areas, but I feel your selection of the directory display was a poor choice. After running the WEDGE program, the directory can be displayed by typing "@$". Note that it is displayed—not loaded—with this command. Is this any more awkward than booting the disk and typing "CATALOG" on an Apple? You also state that because of the side sectors, a relative file fills the entire disk. This is not true—you should say that a relative file *can* fill the entire disk. Many small relative files can be put on one disk.

You should have been more critical



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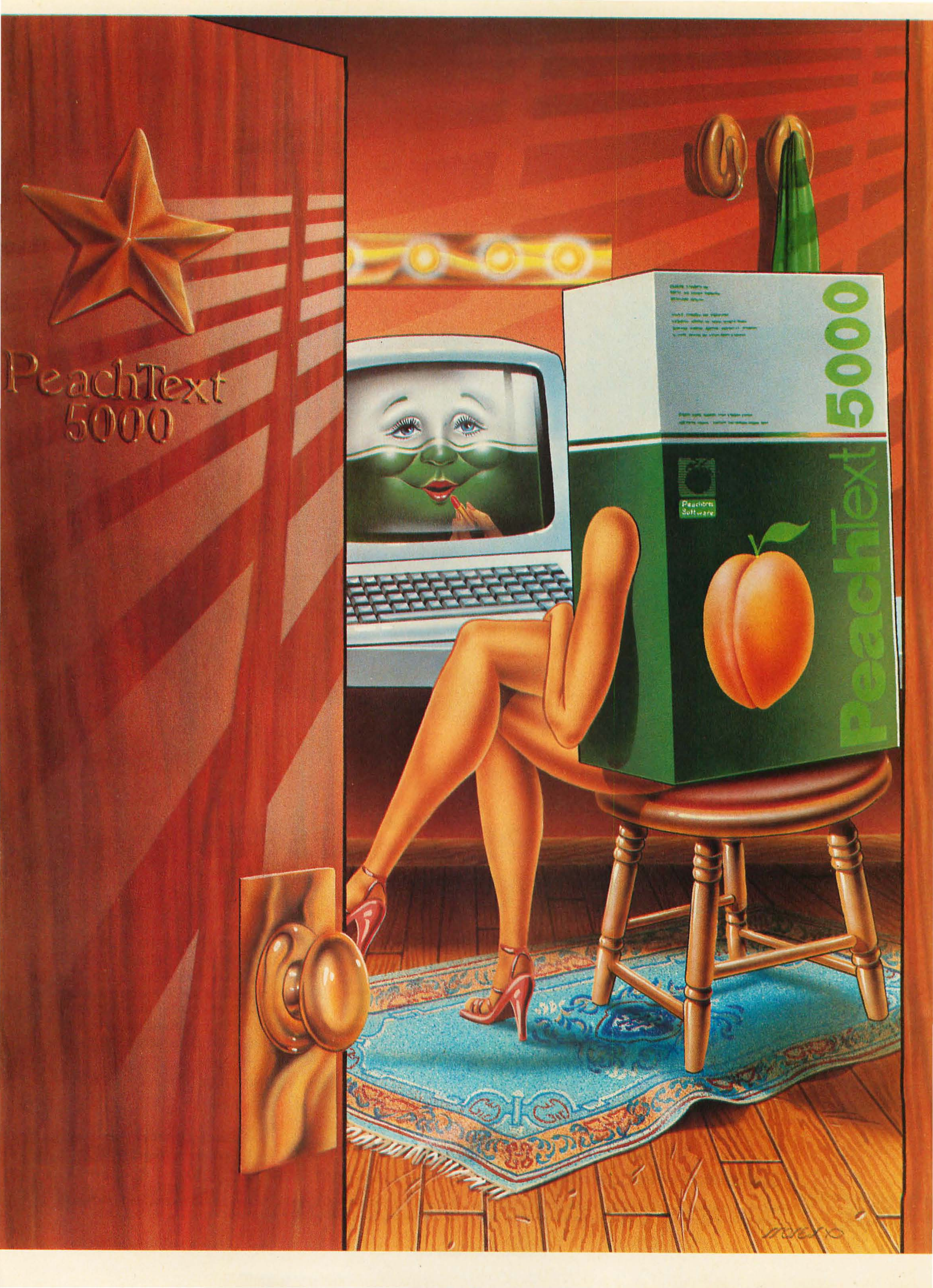
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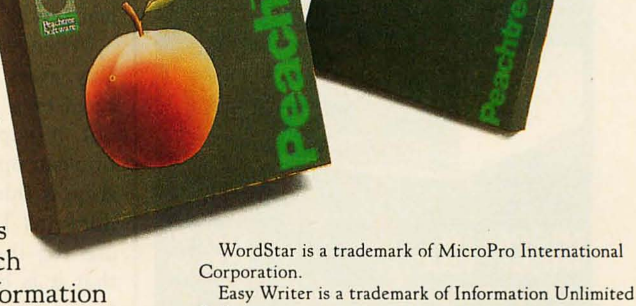
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about the poor quality (or quality control, perhaps) of the RF modulator. Of four TV sets, my Commodore 64 works on only two. Nothing is said in the *User's Guide* about any adjustments that can be made. After a few months of using the *User's Guide* and the *Programmer's Reference Guide*, some of my pages are ready to fall out. I think this is due to the small size of the bindings.

James E. Borden
641 Adams Rd.
Carlisle, PA 17013

Two on Logo

I must applaud Gary Kildall and David Thornburg for "Digital Research's DR Logo" (June, page 208). For the last year and a half, I have been trying to convince school and college administrators that Logo is a powerful, general-purpose programming language. Before Logo was available on microcomputers, I taught college and teacher in-service courses in BASIC. The most common myth about BASIC is that the relatively few primitive operations make it easy to learn. This is believed by those who have never tried to teach BASIC to neophytes. Most first-time users complain about the pickiness of the interpreter regarding misplaced quotes or semicolons, and numerous other things. Some adults I've taught even confuse PRINT and INPUT. Considering that these two statements do opposite things, one begins to wonder if BASIC is easy to learn.

When comparing languages, I always stay away from evaluating specific features of a language, such as whether or not it supports pointer-type variables, Boolean operators, or whatever. The real issue is this: how easy is the language to think in? The metaphor Logophiles often use for the activity of programming is that it is like teaching the computer (or turtle) a new word. More than just a metaphor, this changes your perspective on solving the problem. The fact that people can have personalized input and define their own words gives them a sense of power over the machine and helps them view the computer as a mental aid. This results in less blame being placed on the machine for an incorrect result because the user is the one that created the procedure. The ability to create your own keywords encourages you to say to yourself, "How can I break this task up into chunks that are suitable for keyword definitions?". Of course, it isn't necessary to break the problem up into chunks. The example I often use in Logo courses, drawing stickmen, comes from *Mindstorms*, pages 100–103. Granted, drawing stickmen may be a trivial task on the outside, but most people adopt this stuctured approach because the solution is easier to visualize, easier to think through, and easier to debug, if necessary.

Obviously, I think Logo is an easier language to think in than BASIC. The adults and children I have taught Logo to over the past two years agree. They also agree that Logo is a powerful language. Logo is a dialect of LISP, which, as Kildall and Thornburg put it, "is a powerhouse of a language."

But there is more at stake here than semicolons and quotation marks. Kildall and Thornburg say that Logo demystifies artificial intelligence (AI) and puts AI into the hands of many. This is extremely important. Expert systems and other contributions from AI will greatly affect the way we use computers and will turn the computer into a thinking tool, not one that just crunches numbers very quickly. The impact that a thinking tool will have on society as a whole must be dealt with, and to discuss it intelligently one should understand the ways and means of artificial intelligence (i.e., its theories and its languages).

So wake up, you BASIC fans. LIST is more than just a command that prints out your program.

K. Sharman
42 Rossmere Close SE
Medicine Hat, Alberta
T1B 2J8, Canada

Request for Help

I am looking for a 12-inch green-screen monitor or terminal with shielding to allow use by individuals with special inner ear problems.

The medical problem I refer to allows certain people to hear some normally inaudible high frequencies apparently generated by the horizontal sweep circuits in all televisions and CRT monitors used for computer displays. These frequencies are both heard and felt within the inner ear, resulting in physical nausea, loss of equilibrium, and other related physical and mental distress.

In local experiments with such people, assorted wrapping of some monitors in foam or placing them on foam pads par-

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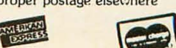
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tially attenuates the high-frequency noise or sound, but not enough to permit the individual to use the installation in an office environment. There is also the problem of reducing the circulation of cooling air through the equipment.

Have other readers run into this problem, perhaps? We would appreciate hearing from anyone who has any suggestions, solutions, monitors, or computer terminals with effective shielding (sound, electromagnetic, or both) for dealing with this problem.

John R. Page, Pastor
Trinity Bible Church
828 Pennsylvania Ave.
Medford, OR 97501

OK Modem Tariff Not Okay

I am writing in regard to a serious problem that modem users in the state of Oklahoma are facing.

Southwestern Bell Telephone Company's Oklahoma tariffs call for the charging of an "Information Terminal Service" rate for anyone connecting a computer to the telephone lines via a modem.

This rate is approximately 500 percent higher than the standard residential base rate. The present residential rate is around $9 per month. If you connect a computer to the line with a modem, even if you only call Compuserve once a month, the rate jumps to a whopping $45.90. The additional charge for Touch-Tone service also increases, from $1.25 to $3.50 per month. This will undoubtedly increase dramatically if Bell gets the $301,000,000 increase that it just applied for with the Oklahoma Corporation Commission.

Obviously, this tariff dramatically affects the entire industry, as the tariff for all practical purposes prohibits noncommercial, hobbyist modem use. And if Bell is permitted to get away with the enforcement of the tariff (as it is now beginning to), a precedent will be set for other local operating companies to follow in other states.

Apparently, Bell is just now beginning to apply this 1965 tariff to noncommercial modem and computer users. And although Bell representatives have fallen back on the age of the tariff as an excuse, they have no intention of exempting residential modem use from the provisions of the tariff.

Therefore, the Oklahoma Modem Users Group (OMUG) is fighting Southwestern Bell and its unfair tariff. We are doing this through media attention, responsible organization, and speaking at Corporation Commission hearings. If all else fails, we will institute legal action to attempt to force a change in the tariffs.

Because of the national attention this issue is just now beginning to attract and the fact that we desperately need more support, we have taken several steps to ensure that people are informed. We have a mailing list, and we send out a biweekly newsletter covering the latest updates on the tariff situation. We have also established a 24-hour hot line that is updated daily with a one- to three-minute recorded announcement; the number is (405) 360-7462.

Robert Braver, President
Oklahoma Modem Users Group
911 West Imhoff Rd., #634
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The HP 150

Magic is the code name for Hewlett-Packard's personal-computer project in Sunnyvale—and it fits. Something magical happens when you use the HP 150. The optical touchscreen trademarked as HPTouch goes beyond other pointing devices; it makes you feel that you have remarkable powers in your fingertips. It's almost as if the touchscreen turns your finger into a conduit between your mind and the computer.

Hardware: Compact, Powerful, and Innovative

This compact machine packs the system-processor unit, memory, video-display unit and control circuitry, three I/O (input/output) ports, and touchscreen electronics into an elegant package that is 1-foot square. Two free-expansion slots permit a network-interface board and expansion to 640K bytes of RAM (random-access, read/write memory). An optional user-installable thermal printer fits in an enclosure at the top of the unit, with its own connecting cable. The dual-floppy-disk unit contains two single-sided Sony 3½-inch disks holding 270K bytes each and has a footprint not much larger than the main unit's. The HPIB bus used to connect the disk drives permits the controller to reside with the drives; no expansion slots are required to add additional floppy or hard disks.

The compactness of the HP 150 does have one drawback for personal-computer users who do intensive computation. There was no way to squeeze a socket in for an 8087 coprocessor. Early indications are that the HP 150 will be an open system with respect to both hardware and software, and perhaps someone will develop an 8087 board for one of the two expansion slots.

Photo 1 shows the back of the HP 150 with its various I/O connectors. In photo 2, part of the back of the system has been removed to expose the two expansion slots, one of which is occupied by a memory board. Photo 3 shows the system with the back removed. The motherboard sits one level above the two expansion slots and holds it own piggyback 256K-byte memory board. Above that, you can see the video-controller board. Photo 4 shows the system from the front with the bezel removed and turned around to face the camera.

The bezel contains the touchscreen electronics—the grid of light-emitting diodes and photo diodes. There are 24 holes in each side of the bezel and 40 holes in both the top and the bottom. This provides touch sensitivity for each row of the display and for each unit of two columns.

The touchscreen leaves no doubt that the HP 150 intends to deliver the power of personal computers to more people—nontechnical people. For HP, always known as an outstanding manufacturer of high-performance products for engineers, the 150 signals a bold entry into the broader market now dominated by IBM and Apple. Cyril Yansouni, general manager of HP's new personal computer division, confirms this interpretation and describes the 150 as the first of a new family of products. Yansouni also says that the HP 150 will be priced competitively, another departure for the company. A standard system with 256K bytes of RAM and two Sony 3½-inch disks providing 540K bytes of storage, MS-DOS, the Personal Applications Manager software, and Microsoft BASIC will retail for approximately the same price as the IBM PC with equivalent memory and mass storage. The HP 150's unique touchscreen and user interface provide the magic in an already powerful computer.

High Performance

Hewlett-Packard's engineers did not forsake their reputation for building high-performance products when they designed the 150. The HP 150's 8088 runs at 8 MHz compared to the usual 5 MHz or less, and the standard amount of dynamic RAM is 256K bytes. There are also 6K bytes of static RAM for the screen and 160K bytes of ROM (read-only memory), bringing the total memory for the standard machine to 422K bytes. One of the two standard RS-232C serial-communications ports also serves as a higher-speed RS-422 port, and several peripherals can be daisy-chained off the HPIB connector, permitting high-capacity mass storage.

Hewlett-Packard makes some magic

by Phil Lemmons and Barbara Robertson



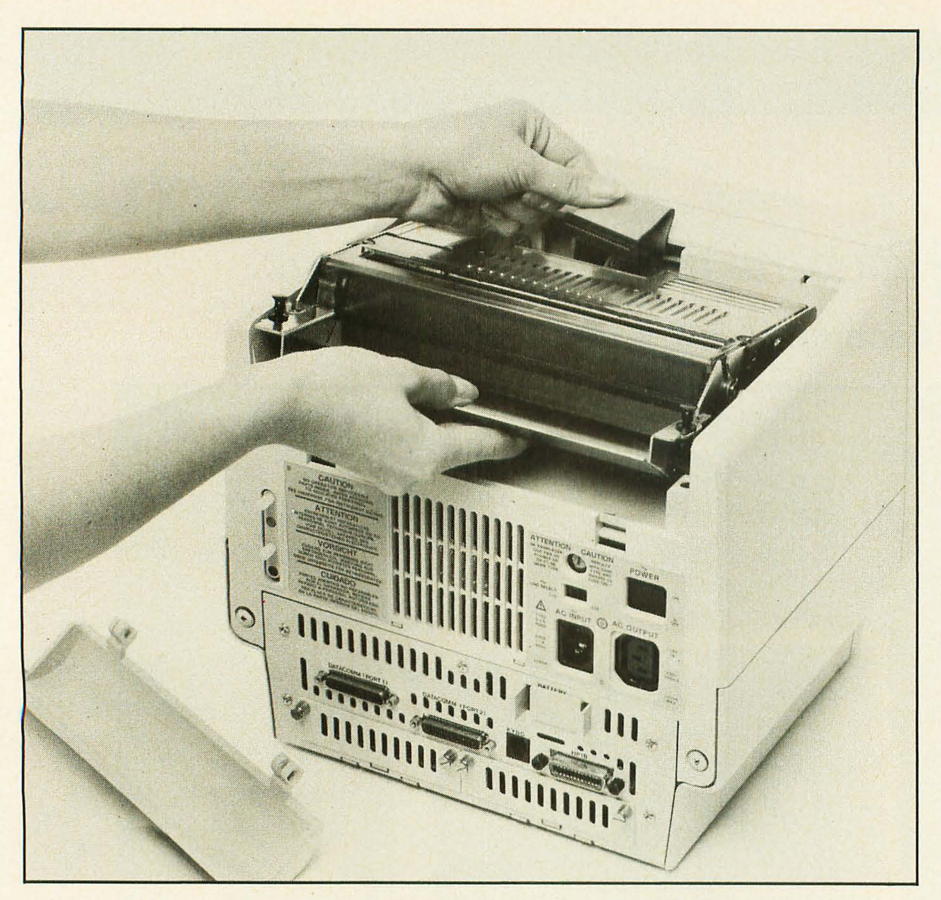


Photo 1: *A back view of the HP 150. Note the two serial ports (DATACOM1 and DATACOM2), the port for HPIB bus (used to connect a series of disk drives and parallel printers), and the easily removed battery.*

Hewlett-Packard plans to introduce the HP 150 at the November Comdex show in Las Vegas and is already working with its dealers to provide all necessary support for that introduction, including major television and print advertising campaigns. According to Cyril Yansouni, general manager of HP's personal computer division, the company is establishing Personal Computer Centers for training dealers and end users. While these centers will not sell equipment or software, a professional training and marketing staff will be available to answer questions, conduct seminars, and refer prospective customers to dealers. Twenty of these centers are already open and 65 additional centers, located worldwide, are scheduled for completion by the end of 1983. For more information on the availability of the HP 150, or the location of a Personal Computer Center, call (800) FOR-HPPC.

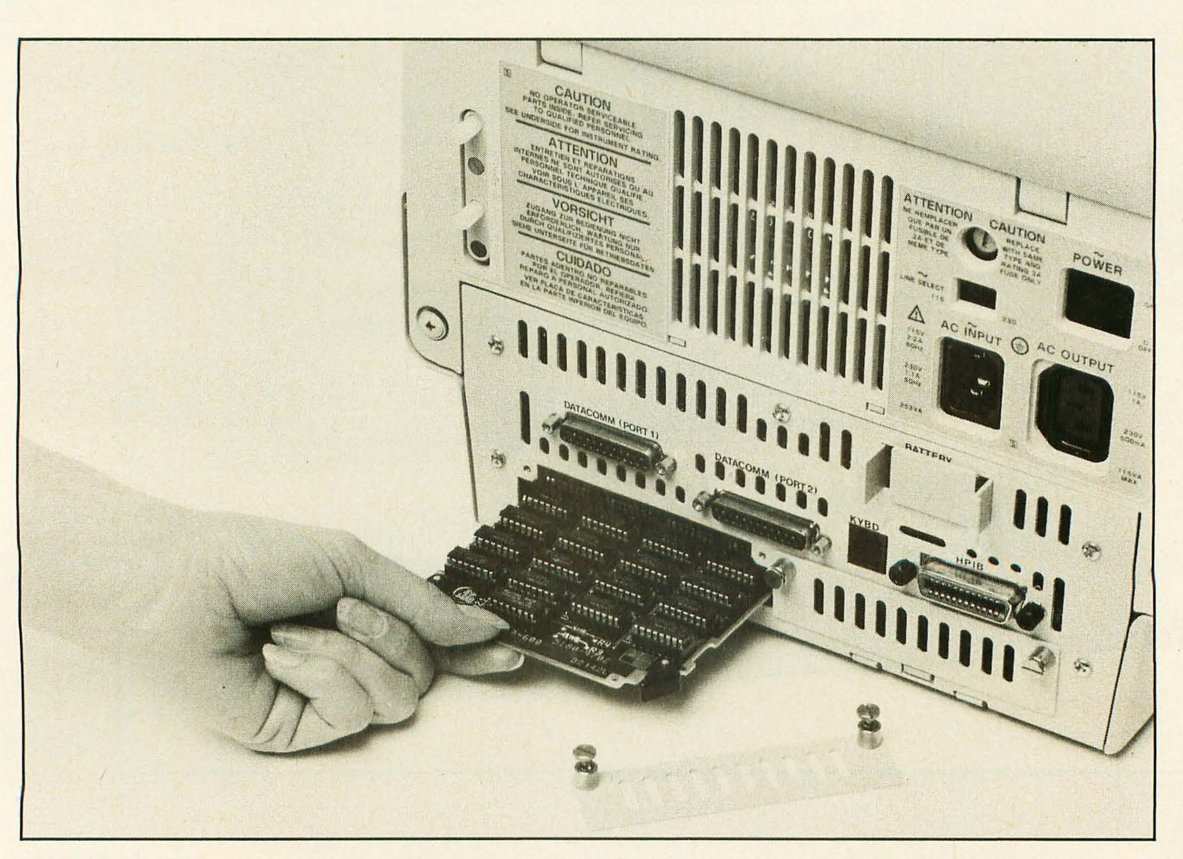


Photo 2: *The HP 150 comes with 256K bytes of RAM. This photo shows an optional 256K-byte memory board in one of the two expansion slots.*

Photo 5 shows the back of the 150 with its complement of I/O connectors and the optional thermal printer on top.

Available disk units include 5¼-inch and 8-inch floppy-disk drives as well as the 3½-inch disks, plus high-capacity Winchester disks. The Sony 3½-inch disks run at 600 rpm (revolutions per minute) rather than slowing down to the 300-rpm standard adopted by an ANSI committee.

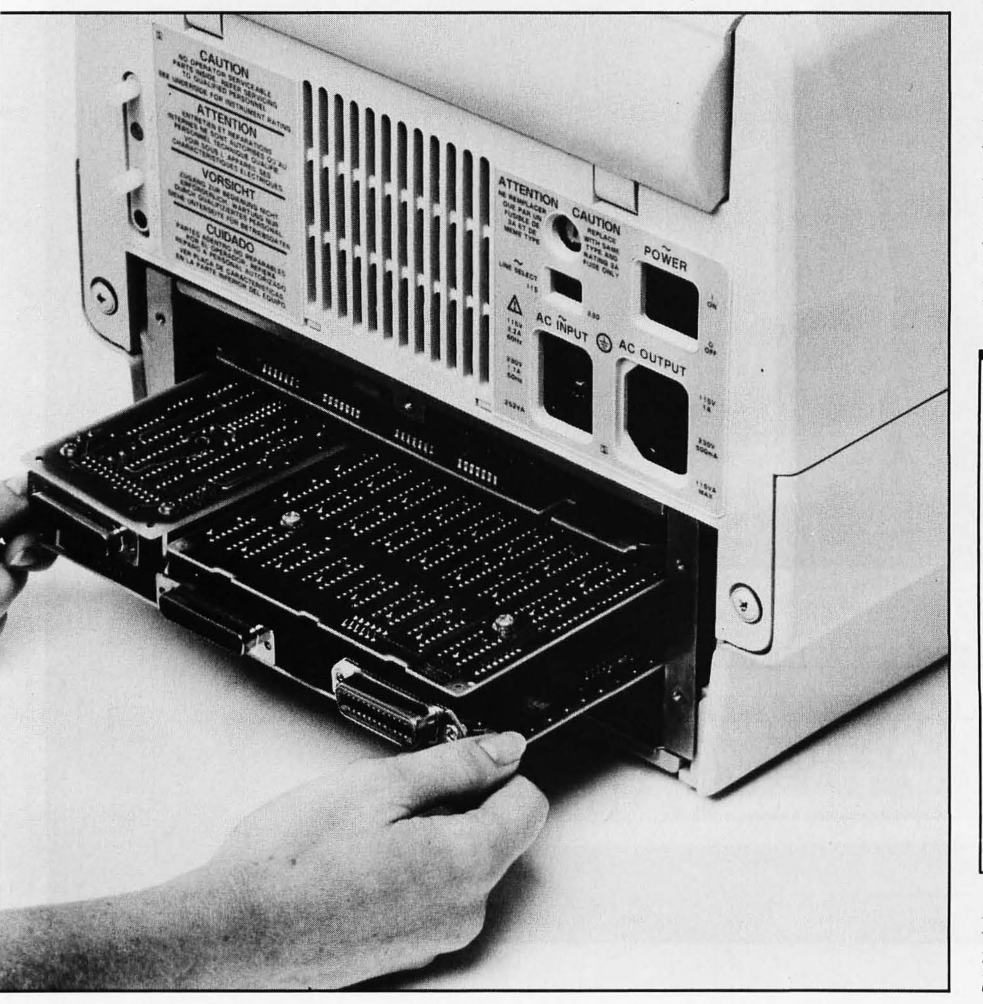
The performance of the video display is also outstanding. The 9-inch screen looks too small until you turn it on. The "At a Glance" box on page 41 shows the HP 150 screen displaying essential facts about the system in a format similar to that of a card in the Personal Card File, an electronic Rolodex-like program available for the 150; a lot of information is displayed quite clearly on the 9-inch screen. With a resolution of 720 by 378 as an alphanumeric display and 512 by 390 as a bit-mapped graphics display, the green-phosphor screen actually displays more pixels (picture elements) than the IBM PC 12-inch monochrome monitor, which has a 720 by 350 display. As an alphanumeric display, the HP 150's little screen provides 27 lines by 80 characters instead of the usual 24 by 80. Each character is formed by a 7 by 10 dot matrix in a 9 by 14 dot cell. The dots shift by half a dot to form clear characters, as the screen photos demonstrate.

The bottom line of the screen is reserved for system-status messages, and the two lines above that label screen areas programmed to perform specific commands when touched (softkeys). That leaves a full 24 by 80 screen plus the extra lines at the bottom for system enhancements.

Two controllers handle the video display. A custom gate array controls the graphics display, while the Standard Microsystems Corporation 9007 VPAC (Video Processor and Controller) takes charge of alphanumerics. As explained in "The CRT 9007 Video Processor and Controller" (April 1983 BYTE, page 96), the 9007 has powerful memory-addressing capabilities and flexible video-timing control. Its 30 registers include 12 to keep screen parameters and others for cursor control and light-pen operation. The 9007's memory-addressing power provides row-table-oriented memory addressing that relieves the system's central processor of the task of moving data on the screen.

The 9007 is partially responsible for the high performance of the HP 150's display in alphanumeric mode and for the gate array for the high-speed graphics, but systems software also plays an important role. Just as separate controllers control the two modes of the display, two separate software modules control screen I/O. The AIOS (alphanumeric input/output system) optimizes character I/O and the GIOS (graphical input/output system) optimizes bit-mapped graphical I/O. The GIOS includes routines for powerful graphics functions such as filling areas.

HP designed the keyboard on the assumption that people should be able to use the computer to its fullest without the touchscreen. The keyboard (see photo 6) has 107 sculpted keys, including cursor controls, editing keys, a numeric pad that can be shifted into a graphics-control pad, and eight programmable func-



Benchmark	HP 150	IBM
Empty Do Loops	6.13	6.43
Division	16.75	23.80
Subroutine Jump	11.80	12.40
MID$ (substring)	19.33	23.00
Prime Number	151.60	190.00

Table 1: *Benchmark results for the HP 150 against the IBM PC. The HP machine was running under MS-DOS 2.0, BASIC86, prerelease version 5.28. The IBM PC was running under PC-DOS 1.0, IBM BASIC. The benchmark programs are from "A Closer Look at the IBM Personal Computer" by Gregg Williams (January 1982 BYTE, page 36).*

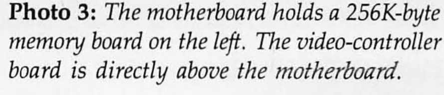


Photo 3: *The motherboard holds a 256K-byte memory board on the left. The video-controller board is directly above the motherboard.*

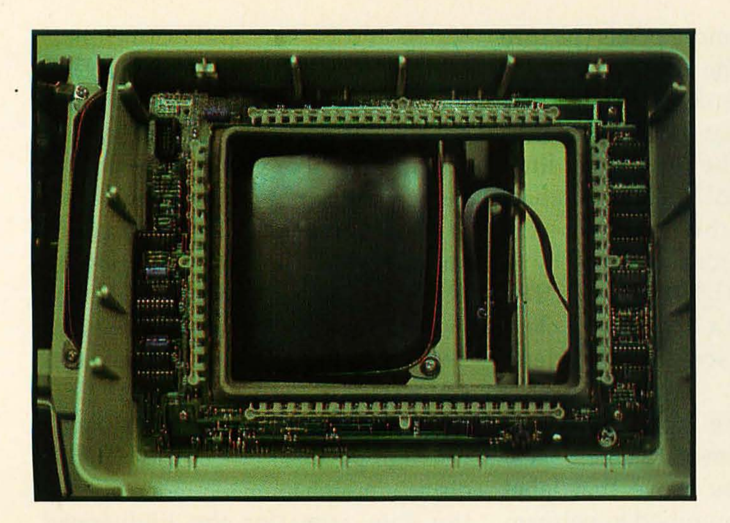


Photo 4: *The inside of the touchscreen bezel with its light-emitting and photo diodes. The system recognizes a touch when an object breaks the light beams crossing the screen.*

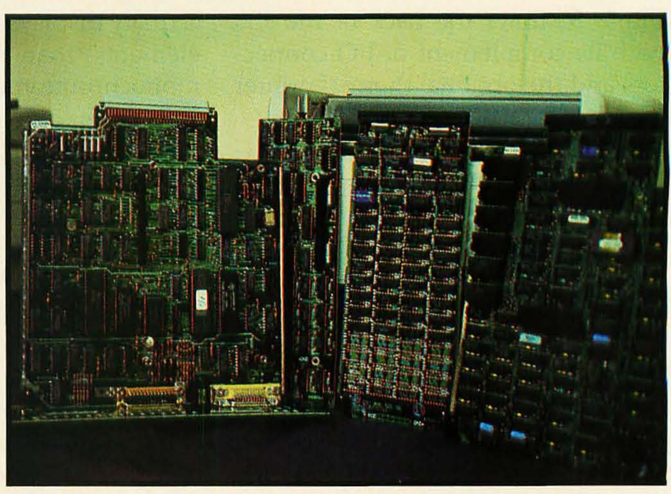
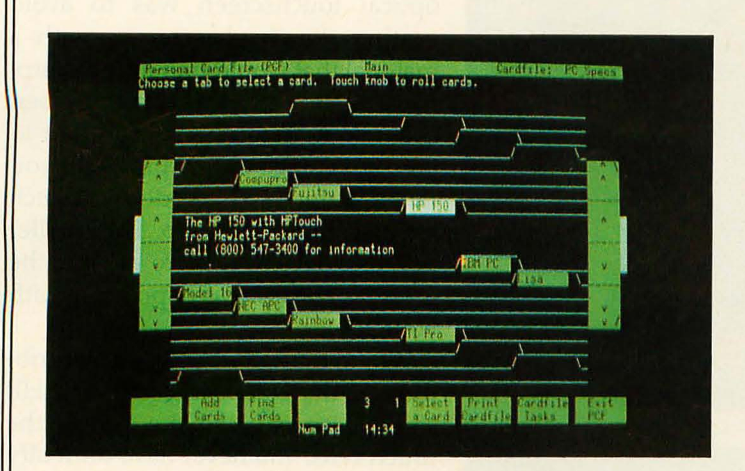


Photo 5: *These boards—the motherboard, piggyback and expansion memory boards, and the video-controller board—are all packed into the tiny monitor. In addition, two boards, the CRT sweep and power-supply boards, stand on end on each side of the video screen.*

Photo 6: *The HP 150 keyboard.*



At a Glance

Touch a tab in HP's Personal Card File program to look at a card at the card file.

tion keys. The layout is excellent. This keyboard will be the standard keyboard for all HP machines and terminals for years to come. An 8041 processor located in the system unit controls both the keyboard and the touchscreen.

An NEC 7201 controls the serial ports with a Texas Instruments controller chip handling the HPIB bus.

Both serial ports will operate at up to 19,200 bits per second (bps) as RS-232C ports and one will also operate as a higher-speed RS-422 port.

BASIC Benchmarks

Although it isn't possible to quantify the display's performance in this product preview, we did try five of BYTE's interpretive BASIC computational benchmarks on the 150, running a prereleased version of Microsoft's BASIC86 version 5.28. Table 1 shows the results. Not surprisingly, the HP 150 did well. In the prime-number benchmark, the HP 150 outdistanced the IBM PC by 38

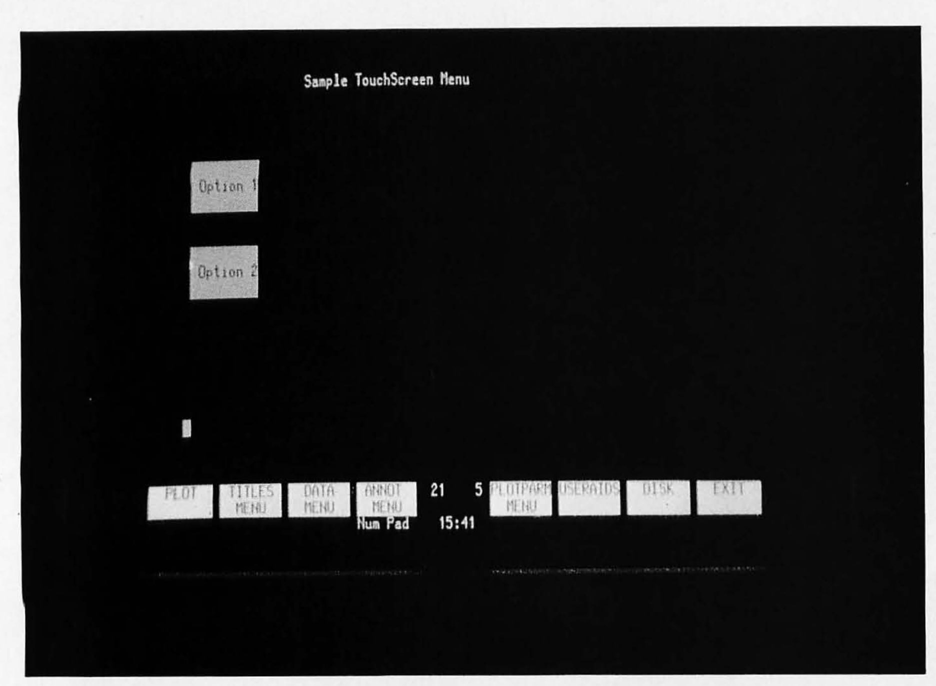


Photo 7: *Options 1 and 2 can be selected by touch. A simple BASIC program created this menu (see listing 1).*

seconds, even though the PC was running IBM PC BASIC, Microsoft's more advanced GW (Gee Whiz) BASIC, rather than BASIC86. The prereleased HP 150 was also significantly faster in the tests of division and string operations. The HP 150's 3½-inch disks performed well in simple disk I/O benchmarks— faster than all but a couple of the machines tested so far—but the results are not published here because HP plans to further improve the drives' performance.

Future products will expand the 150 family to include a compatible portable and transportable unit as well as a version with color graphics. Plans call for enhancement of the 150 family with faster clocks and a more powerful processor. The 150 family will also be able to communicate with non-HP computers through an Ethernet-compatible networking scheme.

The Touchscreen and Compactness

You don't actually have to touch the screen to make the touchscreen work because the beams of light pass slightly above the surface of the screen. One reason for choosing the optical touchscreen was to avoid coating the display screen with a material that would impair the sharpness of the display. Using a screen coat allows greater precision, but to take advantage of this precision you must point with a device much smaller than a fingertip. The smaller pointing devices seem to sacrifice the intuitive correctness of pointing with your finger.

While the 9-inch screen contributed to the compactness of the HP 150, it also reduced the size of the touch cells. You never have difficulty pointing to the defined touch areas at the bottom of the screen, or at the name of a file or program that you want to run, but a single character is difficult to select precisely. The cursor keys provide an easy alternative for fine movements, and pressing the select key selects the desired object.

The touchscreen also minimizes this problem in another way. The system recognizes a touch when your finger breaks the vertical and horizontal beams of light that cross above the object, and shows its recognition by displaying the object in inverse video. But a touch is not equivalent to a selection. The system only recognizes a selection when you withdraw your finger from the area and the interrupted light beams again cross the screen to the photo receivers under the bezel. You can move your finger around the screen for as long as you want, and the

A Potential User Looks at the Software

Phil Lemmons and I sat at his kitchen table late one night with the preview machine and prereleased copies of some of the software that Hewlett-Packard will offer for the HP 150. The touchscreen concept sounded interesting, but the only way to determine how it worked out was to use it.

Before trying any serious applications, we booted up the demonstration disk because I wanted to play with the graphics game. To create a drawing, you must first touch the screen in a least three places to mark the periphery. As I slid my finger around the screen, a small dot of light followed it. When I lifted my finger, the dot changed to a highlighted bar about the size of a typical cursor. This was obviously the first end point for the drawing. I selected several points this way, touched the label Draw Graphic in one of the eight function blocks (softkeys) at the bottom of the screen, and was fascinated as the drawing started from each point and filled in toward the center (photo 8).

I hadn't touched the keyboard once, and I had learned everything I needed to know about using the HP 150 touchscreen: to select a point on the screen, I lift my finger, and to start an operation, I touch one of the highlighted blocks in the row at the bottom of the screen.

Then I moved on to more serious work.

The HP 150 will be packaged with

system continues to highlight every object as your fingertip passes or touches it. When the desired object is displayed in inverse video, you simply withdraw your fingertip and the system acts on your selection. This visual feedback compensates for the limited precision of the array of touch areas. Whether the HP touchscreen will meet your needs depends on the precision you require. If you need to select individual pixels, HPTouch won't do. But the touchscreen takes care of much of the interaction during applications programs, making many system-level operations effortless and natural. Touch is the easiest input device to learn and the hardest to give up.

But can you use the touchscreen as an input device in your BASIC programs? Yes. Miles Kehoe of HP provided a quick example of a touch-sensitive menu. (See photo 7 and listing 1.)

If you wonder what it's like to use the touchscreen in more sophisticated programming, read the programming sidebar, "Adapting Existing Programs to Use HPTouch: Picture Perfect, Diagraph, and Wordstar" on page 48. It describes Micropro's experiences in adapting Wordstar (written in assembly language) to use the touchscreen and Computer Support Corporation's experiences in adapting the graphics programs Picture Perfect (written in BASIC) and Diagraph (written in Pascal).

—Phil Lemmons

Listing 1: *This simple BASIC program will create the menu shown in photo 7.*

```
1000 '
1010 'Sample Menu Selection Sub-Program us
1020 'Provided by TLA. All Rights Reserved
1030 'use of these routines is permissible
1040 '
1050 WIDTH 255                              'Set 'infinite' screen width
1060 CLS$=CHR$(27)+"h"+CHR$(27)+"J"         'Home up, clear display
1070 '
1080 'FNLOCATE is similar to the LOCATE command in some BASICs
1090 '
1100 DEF FNLOCATE$(ROW,COL)=CHR$(27)+"&a"+
             STR$(ROW)+"r"+STR$(COL)+"C"
1110 '
1120 'FNTOUCH will define a touch field on the screen. The field
1130 '       will be three rows long and eight columns wide
1140 '       starting at the specified row and column. The
1150 '       character string to be returned is specified in
1160 '       the last parameter, and may be from 0 to 80 bytes
1170 '       in length.
1180 '
1190 '       The function as defined uses just one of many modes
1200 '       of touch field definition. The general form of the
1210 '       escape sequence is:
1220 '
1230 '    ESC  - z g <row1>,<row2> r <col1>,<col2> c
1240 '
1250 '            <0/1> b <onenh> e <offenh> f
1260 '
1270 '            <rptmode> m <attr> a  <len> L  <response>
1280 '
1290 '   where:
1300 '
1310 '      The 'b' field determines whether a touch will beep;
1320 '
1330 '      The 'e' field specifies the video enhancement of the
1340 '      field when NOT being touched
1350 '
1360 '      The 'f' field specifies the video enhancement of the
1370 '      field when it IS being touched
1380 '
1390 '      The 'm' field specifies the type of field (ie, row/col
1400 '      reporting, ASCII (as shown here), etc.)
1410 '
1420 '      The 'a' field specifies when to report (on touch, on
1430 '      release, or both). ASCII mode is considered a 'keyboard
1440 '      replacement', hence reports on touch only regardless of
1450 '      this field (just like a keyboard key)
1460 '
1470 '      The 'L' specifies the length of the desired response string
1480 '
1490 '      <response> indicates the string to return when touched and
1500 '      may include a carriage return if desired
1510 '
1520 DEF FNTOUCH$(ROW,COL,CHARS$)=CHR$(27)+"-zg"+
       STR$(ROW)+","+STR$(ROW+2)+"r"+
       STR$(COL)+","+STR$(COL+8)+"c"+
       "1b10e2f2m1a"+STR$(LEN(CHARS$))+"L"+CHARS$
1530 '
1540 REPT.MODE.ON$=CHR$(27)+"-z2n1A"        'Enable touch reporting
1550 REPT.MODE.OFF$=CHR$(27)+"-z0N"         'Disable touch reporting
1560 TOUCH.DELETE$=CHR$(27)+"-zD"           'Delete ALL touch fields
1570 '
1580 '  Display Main Menu
1590 '
1600 PRINT CLS$;                            'Clear screen
1610 PRINT FNLOCATE$(0,20);"Sample TouchScreen Menu"
1620 PRINT FNTOUCH$(5,5,"1");               'Define touch field in
1630 '                                       row 5-7, column 5-13 to
1640 '                                       return ASCII '1'
1650 '
1660 PRINT FNLOCATE$(6,6);"Option 1";       'Put label in field 1
1670 '
1680 '
1690 PRINT FNTOUCH$(10,5,"2");              'Define touch field in
1700 '                                       row 10-12, column 5-13 to
1710 '                                       return ASCII '2'
1720 '
1730 PRINT FNLOCATE$(11,6);"Option 2";      'Put label in field 2
1740 '
1750 'Now enable reporting and wait for a character
1760 PRINT REPT.MODE.ON$;                   'Turn on reporting mode
1770 'Input single character from keyboard OR touchscreen
1780 A$=INPUT$(1)
1790 PRINT REPT.MODE.OFF$;                  'Turn off reporting
1800 IF INSTR("12",A$)=0 THEN PRINT CHR$(7);:
                            GOTO 1760            'Did not type a 1 or 2
1810 IF A$="1" THEN CHAIN"PROG1"                 'Selection 1
1820 CHAIN"PROG2"                                'Must be Selection 2
1830 END
```

MS-DOS, Microsoft BASIC, and a program called Personal Application Manager. I wanted to follow the process a new buyer would—booting the operating system, formatting some disks, and copying the master. From there I would look at some of the application-software packages that will be available for the machine, including some old friends that have been modified for the touchscreen and some new programs developed for the HP 150.

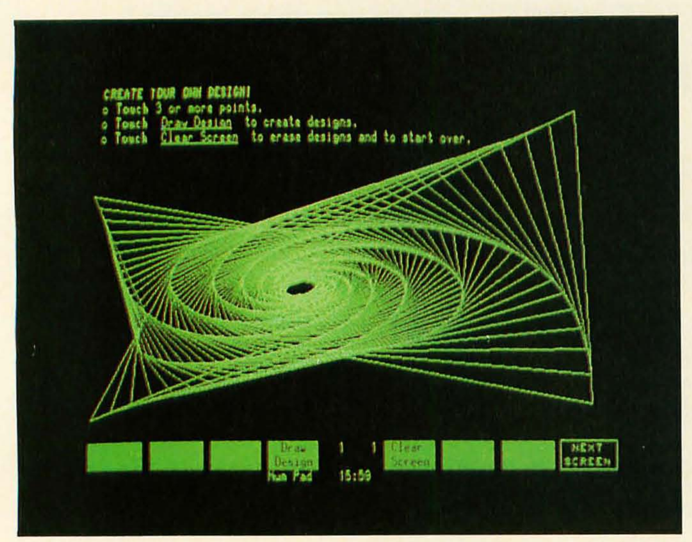


Photo 8: *A graphics-demonstration program by Hewlett-Packard for the HP 150.*

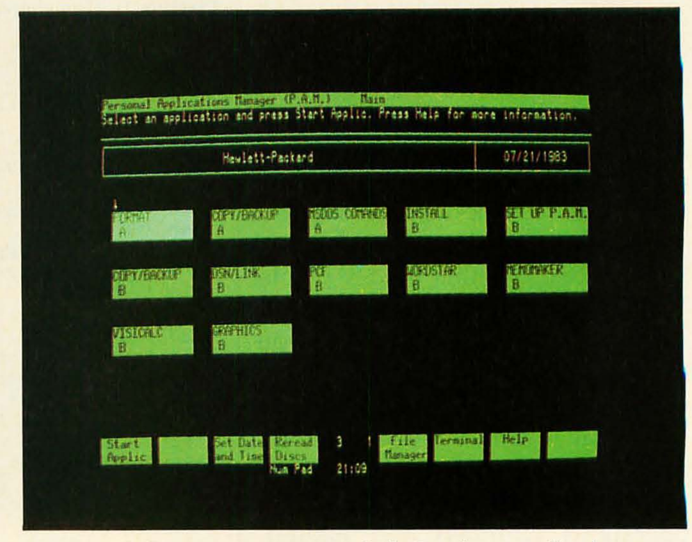


Photo 9: *HP's operating system shell. Touch an application name to select it, then touch "Start Applic." to run it.*

P.A.M.

When you boot the system, instead of the familiar A> from MS-DOS and a blank screen, you see Hewlett-Packard's Personal Application Manager, P.A.M., on the screen. P.A.M. automatically displays in alphabetical order the names of all the installed programs on the disk. Photo 9 shows the first screen with several installed applications displayed.

A small arrow pointed to the application named Format A, and it was highlighted, so I knew this was the default selection. I simply touched the Start Applic. softkey and the format screen appeared, with several bars indicating disk drives (photo 10). I touched the second bar for drive B, typed a label for the disk when prompted, then touched HP Format. A small asterisk appeared next to the label. When the formatting was completed, the Exit Format softkey returned the P.A.M. main menu.

Three touches to format a disk, and I didn't have to learn or remember any operating-system commands! The only time I used the keyboard was to type the optional disk-drive label.

Hewlett-Packard decided early in the project to use the standard MS-DOS operating system (although the company added some features—see the interview with Jim Sutton and John Lee on page 51) so that many popular software packages could run on the HP 150. To facilitate learning and use of the system, they created P.A.M. as a shell for the operating system.

The first P.A.M. screen (photo 8) demonstrates the convenient and simple user interface. This interface is common to all the programs Hewlett-Packard is offering for the HP 150: at the top, a program and menu name followed by a line for application prompts and messages, and at the bottom, a row of softkeys followed by a line for system messages and the clock. (Hewlett-Packard wasn't sure if the clock would be in the final version. Personally, I hope it is. I often lose track of time when I'm working on a computer.)

The softkeys replace traditional function menus whose items are usually selected by typing in code letters or numbers. In addition, each softkey in a row can lead to an entire tree structure of more softkey functions accessed by touching the screen.

The software discourages accidental selections. You must move your finger directly into the softkey area. Sliding to a softkey doesn't work. However, because you don't actually have to touch the screen, a finger hovering in the softkey area sometimes produces unexpected results. Selections are always highlighted for visual feedback, and in addition, when a softkey is selected, it clicks.

The function keys at the top of the keyboard mirror the softkeys on the screen. You can carry out any operation named on a softkey using the corresponding function key.

Now to copy the master disk. After I touched the Copy/Backup softkey, screen messages prompted me to type the drive letters to copy from and to. When I entered A: (copy from) the names of all the directories and files on the disk in drive A appeared on the screen. I chose the Copy File softkey when prompted; I suspected I could select any files I wanted to copy by touching the filenames, and in fact, I could. As I moved my finger from one to another, highlighting each in turn, the small arrow followed. Only names from which I lifted my finger remained highlighted (photo 11). The Start Over or Unselect by Name softkeys undo selections.

I wanted to copy the entire master disk, so when I finished playing with the touchscreen, I touched the Select All and Start Copy softkeys. The number of bytes available on the disk in drive B (in the counter at the top right of the screen) decreased until they matched the bytes available for drive A. The computer politely beeped when it was finished.

Four touches (and two disk-drive letters typed) from the File Manager menu, and I had copied the master disk.

In addition to the Copy Files func-

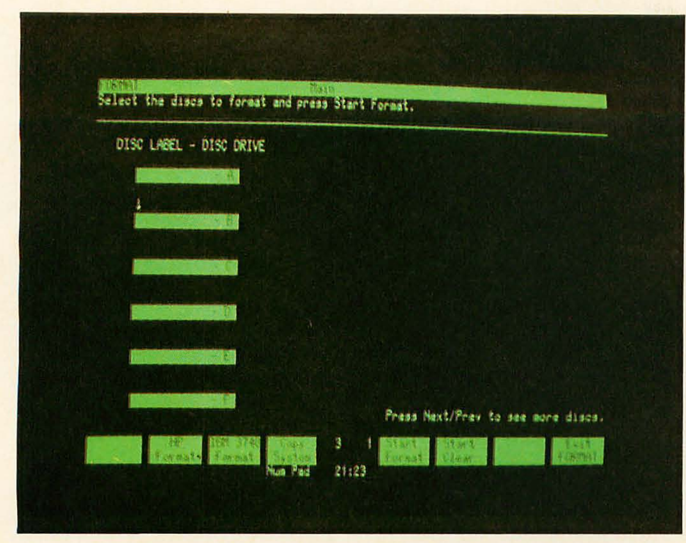


Photo 10: *You can format disks in several drives simultaneously.*

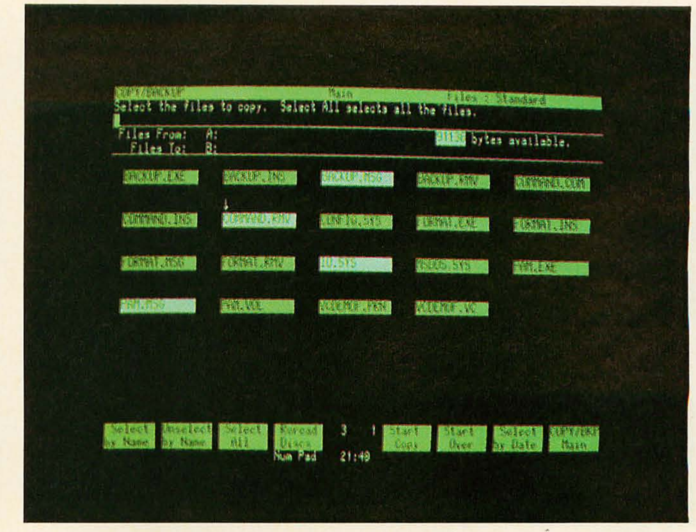


Photo 11: *Select files to copy by touching the filename on the screen.*

tion, P.A.M. has a Backup function that stores files in a compressed format. With this function, you can select files by name or date. The program has enough intelligence to know when there is not enough space left on a disk for the next file and will fill the remaining space with smaller files, then prompt you to change disks. Users with hard disks will find the Backup function especially helpful for archiving data on floppy disks.

The P.A.M. shell works. It simplifies standard MS-DOS functions such as formatting and copying disks. Enhancements such as automatically displayed directories are convenient.

All the programs offered by HP are automatically installed to run under P.A.M., and programs added later are easy to install. You can customize P.A.M.—changing application names, rearranging names on the screen, setting any application to start automatically—all by touching softkeys. Users who prefer standard commands can select the MS-DOS Commands application on the main P.A.M. screen.

When you have disks in more than one drive (the HP 150 can handle 12 disk drives), P.A.M. will display, alphabetically, the names of all the installed programs on all the disks along with the letter code for the disk drive. Disks in several drives can be formatted simultaneously.

The P.A.M. instructions are easy to understand, consistent, and predictable. I used the system without once consulting a manual. There's no need to learn how to use the pointing device to position the cursor: there is nothing abstract about touching a particular place on the screen with your finger. In contrast, most computer systems require users to learn, remember, and always type correctly cryptic codes such as "dir a:" and "copy a:filename.xxx b:filename.xxx" in a precise and initially mysterious format. Utility programs created specifically for a touchscreen are remarkably easy to use. I wanted to see how touch changed some old friends: Visicalc and Wordstar. They are among the applications that will be available when the HP 150 is introduced.

Visicalc

I touched my way back to P.A.M., selected Visicalc, touched Start Applic., and saw Visicalc on screen. Just as in P.A.M., the top line of the screen contains the program and menu names, the second line a message, and at the bottom is the familiar row of softkeys.

Rather than create a new worksheet, I chose one from the directory displayed in the File Manager. It's easy to move back and forth from any application to the File Manager. Touching the File Manager softkey puts the application on hold; the Back to Visicalc key sends you back where you were (see photos 12 and 13).

Of course, I immediately wanted to know if I could select a cell by touching it. I could, although it's a little tricky. It's easy to highlight the column you want, but positioning the highlighting on a particular row takes some practice. Still, it's often a lot easier than typing.

The softkeys contain most of the Visicalc commands, and I was able to use touch alone to move cells, replicate, open multiple windows, and select format and printing functions. Data can be transferred to a graphics program by touching a softkey (see photos 14 and 15).

Experienced Visicalc users may find the familiar slash commands faster than touching softkeys. But they will be pleased with enhancements like additional print functions (photo 16), cell formats and protection, and multiple windows.

Wordstar

My fingers did the walking back to the familiar Wordstar opening menu, touched a softkey to open a file, and typed a new file name. A screen, blank except for the softkeys, quickly appeared (photo 17). Having the Wordstar help menus on the screen would be redundant, so the help level is set to zero, allowing most of the screen to be used for text.

I couldn't wait to try my nemesis, a block move. I succeeded in mark-

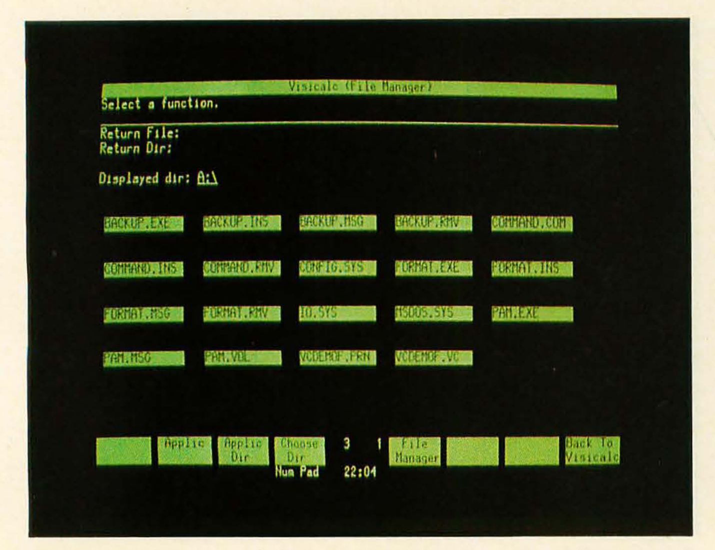


Photo 12: *You can move back and forth between an application and the File Manager by touching softkeys.*

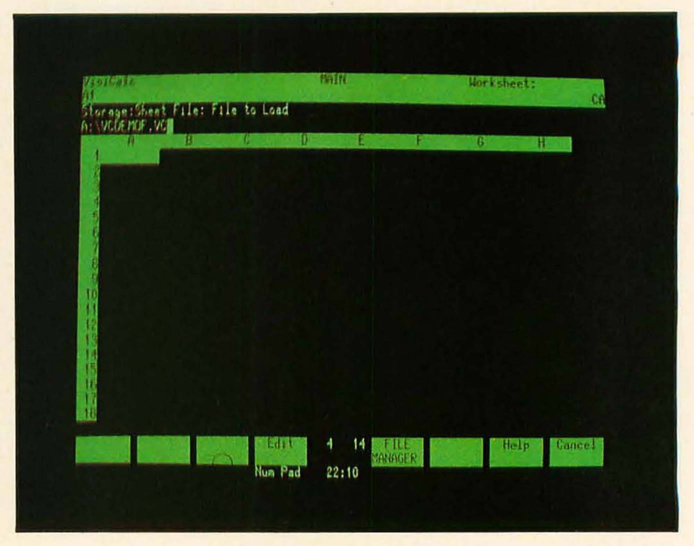


Photo 13: *A worksheet selected via the File Manager (see photo 12) being loaded into Visicalc.*

ing and moving a block of text with a few touches on the screen and softkeys (photos 18 and 19).

One of the most frequent objections to Wordstar is the difficulty new users have in learning and remembering the multitude of command codes. The IBM PC version 3.3 alleviates some of this problem by assigning 10 user-modifiable control codes to the 10 function keys and displaying labels across the bottom of the screen. The HP 150 version of Wordstar takes this idea a bit further: all the commands are on softkeys. Choosing a softkey label marked with lowercase letters produces more commands. Many of the softkeys lead to a whole tree structure of functions.

Typists who prefer not to take their fingers from the keyboard can use the inherent Wordstar commands or function keys. The keyboard has dedicated keys for common commands such as Insert Line, Delete Line, Clear Line, and Insert Character.

The ability to touch the screen to position the cursor makes many editing functions much easier. However, because the touchscreen is accurate only to a 2-character width (see the interview with Jim Sutton and John Lee on page 51), you may need to use the keyboard for exact positioning. Of course, you can't touch what you can't see, but the keyboard facilitates scrolling with Roll up/Roll down and Next page/Previous page keys.

In summary, the touchscreen improves Wordstar and Visicalc. Although these two programs are old friends to many of us, even the best of friends have a few nasty habits that we wish they could break. In the case of Wordstar and Visicalc, the nasty habit has been the refusal to understand anything but control codes and command strings. HPTouch has reformed these two old friends and made them much more agreeable.

Memomaker

You might well ask why, if Wordstar is available for the touchscreen, HP would offer a second word processor. HP's Memomaker is a simple word processor, compatible with Wordstar and designed for people



Photo 16: *Visicalc print options can be selected and changed with touch.*

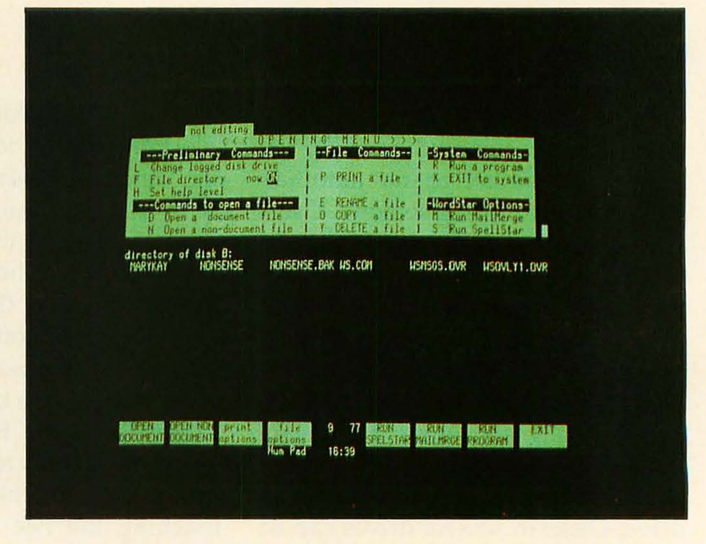


Photo 17: *Wordstar on the HP 150. Softkeys with lowercase letters lead to another layer of functions.*

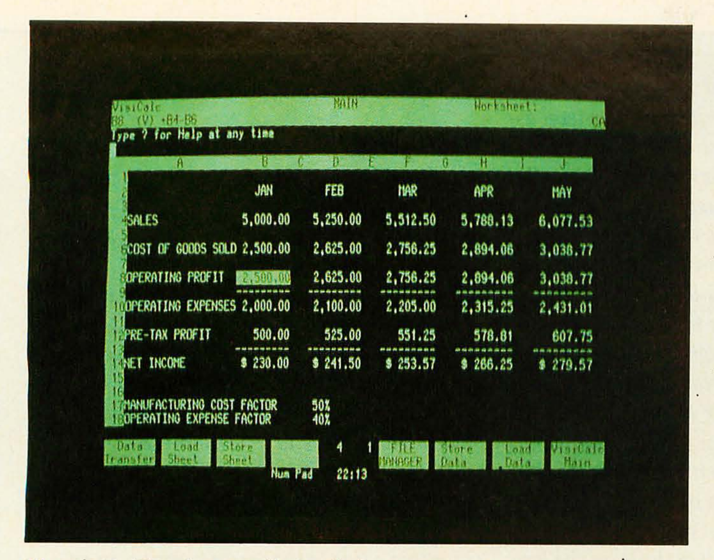


Photo 14: *To select a cell, touch it.*

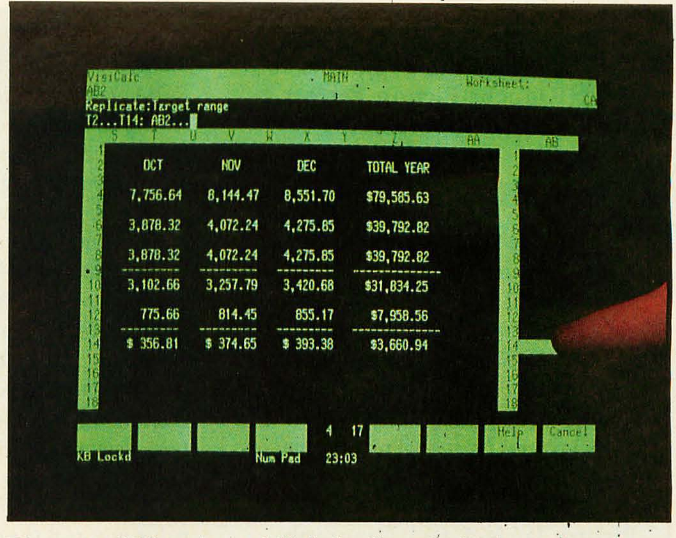


Photo 15: *HP's enhanced Visicalc allows multiple windows.*

who want a quick and easy way to enter text.

Even with the advantages the HP 150 gives to Wordstar, many people don't need or want to learn how to use a full-featured word processor. That's why HP offers Memomaker. With touch to position the cursor and select softkeys, and dedicated keyboard keys for functions such as inserting a line and deleting a character, you don't need to learn or remember any commands. Most people could use Memomaker fully—to write letters, create memos, and do rough drafts—without ever reading the documentation.

As in Wordstar, I used the touch feature to position the cursor and do block moves. I also tried changing the right margin and realigning the text. Touch makes these functions as simple as they should be. (See photos 20 and 21.)

I could go to File Manager, select files, and read them into Memomaker without ever using the keyboard or learning any commands (photo 22).

Memomaker shows text enhancements on screen—highlighting emphasizes boldface, and italic characters indicate underlining. Margins, tab settings, and standard memo formats can be stored in format files and read into a document.

Because Memomaker and Wordstar are fully compatible, documents created in one can be edited in the other. An experienced Wordstar user can add advanced features to Memomaker documents, while someone unfamiliar with Wordstar can use Memomaker to edit a Wordstar document. Memomaker is a great little word processor for people who don't want to do serious word processing.

Personal Card File

The demonstration program for the HP 150 includes a sample of a name and address program called Personal Card File (PCF). The screen for this program has a drawing that looks like a typical rotary card index found on many desks. To access a card in the file, you touch a tab as if the card file were made of paper and plastic; to rotate the card file, touch the handles—again, as you would with a

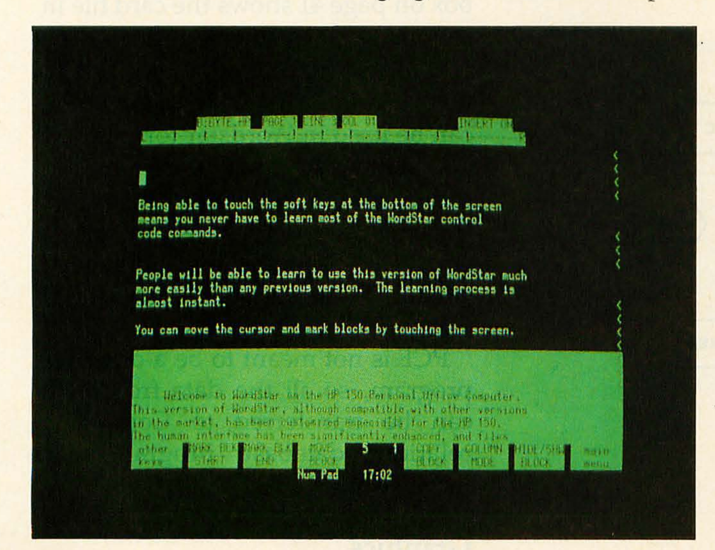


Photo 18: *The cursor shows where I touched the screen.*

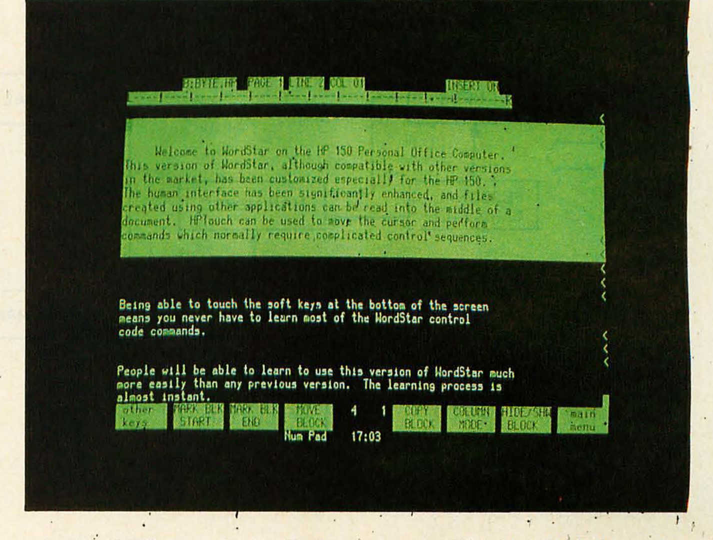


Photo 19: *The result of a block move accomplished entirely by touch.*

Adapting Existing Programs to Use HPTouch: Picture Perfect, Diagraph, and Wordstar

Two software houses experienced different levels of difficulty in adapting existing software for the HPTouch system of the HP 150 Personal Computer. Computer Support Corporation found it easy to adapt its graphics software, but Micropro had some problems because of the unusual internal structure of Wordstar.

Picture Perfect and Diagraph

Picture Perfect is a general charting program that makes it easy to do business graphics, such as bar charts with three-dimensional effects. Diagraph is a program that lets you draw flow charts, organization charts, circuit diagrams, and the like by using a library of approximately 100 primitives, including a variety of polygons and many common symbols. Computer Support Corporation of Dallas, Texas, is adapting two programs to run on the HP 150 and to use HPTouch. One program is written in Pascal and is being rewritten in the Pascal of the HP 150. The other program is written in BASIC and is being converted to the Pascal of the 150.

Michael Kallet and Jack Hudler of Computer Support explained how to use HPTouch this way: "You access the touchscreen through the HP 150's AIOS (alphanumeric input/output system), which is in ROM. You need to write some low-level assembly-language routines to access the AIOS. The same linker on the 150 handles both assembly language and Pascal.

"In fact, you access the touchscreen just as if it were any other input/output device. You call an assembly-language routine to set up the mode of the touchscreen that you want to use. We thought we would always be defining touch areas in terms of coordinates, checking for touches within the coordinates, and then going to commands that were mapped to the touch areas. But the touchscreen has a mode that makes the touch areas actually return a particular value just as if they were keys on the keyboard. Another mode lets the user define an object by touching the screen.

"The most useful mode is the one that makes the touch areas return keycodes. You turn that mode on and then set the touchscreen to report when it's been touched. Then you read the keyboard and wait for the return of a keycode and a qualifier. The qualifier says whether the code came from the keyboard or the touchscreen.

"Because of its different modes, the touchscreen is more powerful than you realize at first. You could use the row-column mode all the time if you wished, but you end up using the mode that directly returns a particular value.

"In interpretive BASIC, you can turn screen areas on and off with escape sequences. In Pascal, you make assembly-language calls to AIOS routines. Interfacing to HPTouch is easy in either case."

Adapting Wordstar

Since Wordstar is written in assembly language, Micropro is using assembly-language calls to the AIOS to adapt the popular word processor for HPTouch. Programmer Joe Masters reports, "For every character typed or screen area touched, you get information about which device the returned value came from, whether shift or control was pressed, and so on. This information comes to you from the console I/O portion of the operating system. The AIOS interprets the information.

"There are routines in the AIOS for writing a line to the screen, writing an entire screen, getting coordinates from the screen, and so on. The existing Wordstar makes multiple single-character output calls to write a line. With the HP 150, you can write an entire line at a time by calling a routine in the AIOS. It's difficult to get used to, but once you do, development goes much faster."

Kirk Hurford, manager of Micropro's OEM support group, explained the method of adaptation: "In adapting Wordstar for specific hardware, we go directly toward the I/O. Wordstar operating in the MS-DOS environment has much slower I/O because of the path that it takes through the operating system. In the case of the HP 150, the effect that we put forth to improve performance is sophisticated. There is a fair amount of intelligence with which Wordstar makes decisions as it's up-

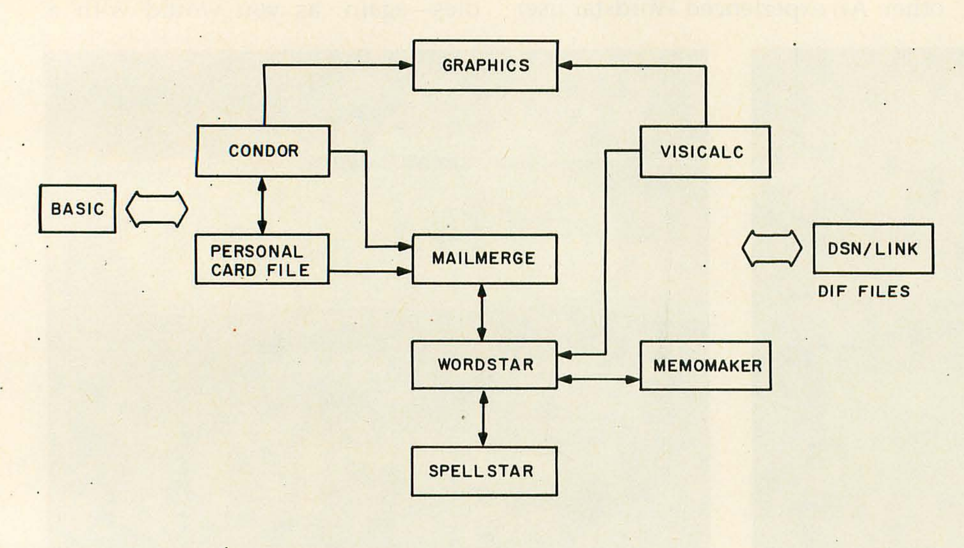


Figure 1: *This map shows the data transfer possible among the HP 150 applications.*

desktop cardfile. (The "At a Glance" box on page 41 shows the card file in action.)

PCF is designed to keep a handy list of names and addresses (which can be used in Wordstar form letters via Mailmerge). Key-field data appears on the tabs, and the file is sorted in key-field order. To search and select data for an abbreviated version of the card file, select fields and type the criteria.

PCF is not meant to be a database program, so all the data from PCF can be transferred to Condor, a relational-database program, for more sophisticated manipulation.

Graphics

With the high-resolution screen and a good selection of plotters

dating the screen. Wordstar uses different AIOS calls based upon what it knows it's going to do. When it's updating characters, for example, it uses different functions from those it would use when it knows it's going to write an entire line.

"Without the AIOS, we would not have achieved the high level of I/O performance that we have on the 150. The only other version of Wordstar that is as fast is the latest version for the IBM PC. That took three programmer months. Achieving the same speed on the HP 150 took five programmers weeks."

Masters made it clear that the hard part of adapting Wordstar for the 150 was on the Wordstar side, not the HP side. "The part of the adapting that has to do with the touch interface itself is self-explanatory. The documentation and a test program have examples of using the AIOS. But what we're doing on the Wordstar side is difficult."

Hurford explained why: "Wordstar is 14,000 lines of assembly-language code. The customization of the HP 150 is complex even though we get the information that we need from the AIOS instantly. It tells us where to go on the screen. The hard part is telling Wordstar how to get there."

"Wordstar identifies a screen location," Masters said, "not by referring to coordinates on the screen but as a 24-bit position in the file. There are lots of translations that have to take place to make Wordstar understand what the AIOS has told it."

available from Hewlett-Packard, it's not surprising that HP will be offering three graphics programs for the 150—its own Series 100 Graphics plus two from Computer Support Corporation (Picture Perfect and Diagraph).

The Series 100 Graphics can use data from Visicalc or Condor to plot bar charts, line graphs, pie charts, and scattergrams on paper or slides. You can transfer data in, select pen colors and shading, choose options such as horizontal or vertical orientation, and pick paper type all by using touch. Photo 23 shows the Series 100 Graphics screen.

Photo 24 shows a bar chart created with Picture Perfect. Because of the HP 150's high resolution, the bar chart assumes an almost three-

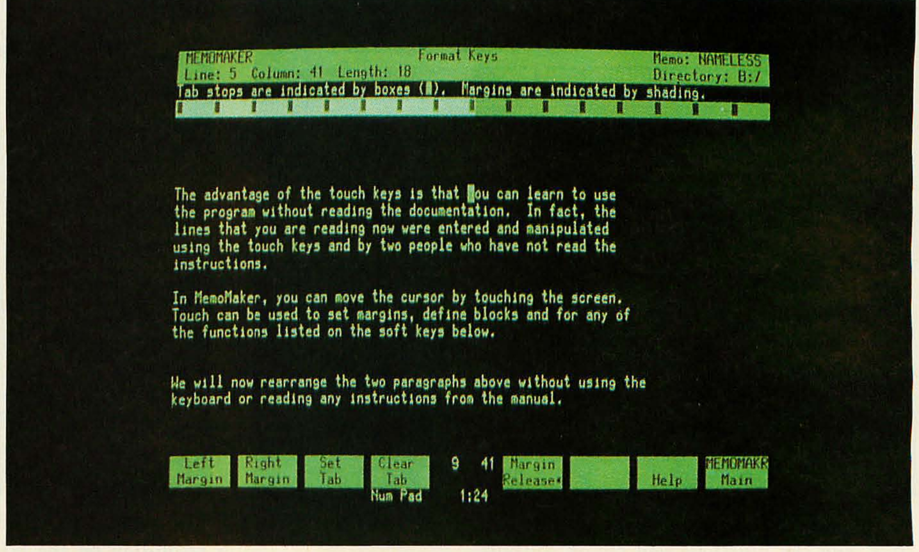


Photo 20: *All the commands for Memomaker are on softkeys. The cursor is positioned for a new right-margin setting.*

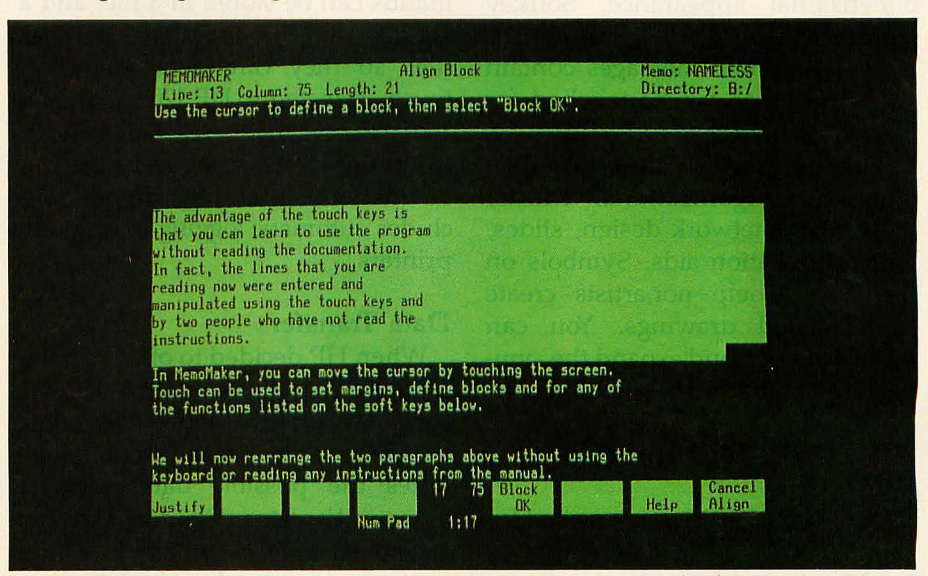


Photo 21: *Realigning a block of text for the new right margin can be accomplished entirely with touch.*

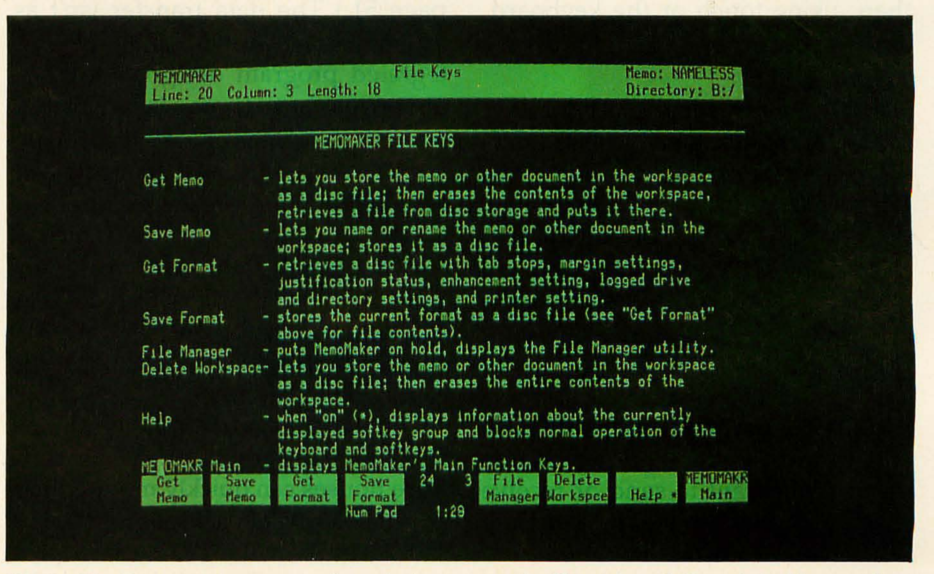


Photo 22: *You can store memo formats in a separate file and read them into Memomaker. The asterisk in the Help softkey shows Help is toggled on.*

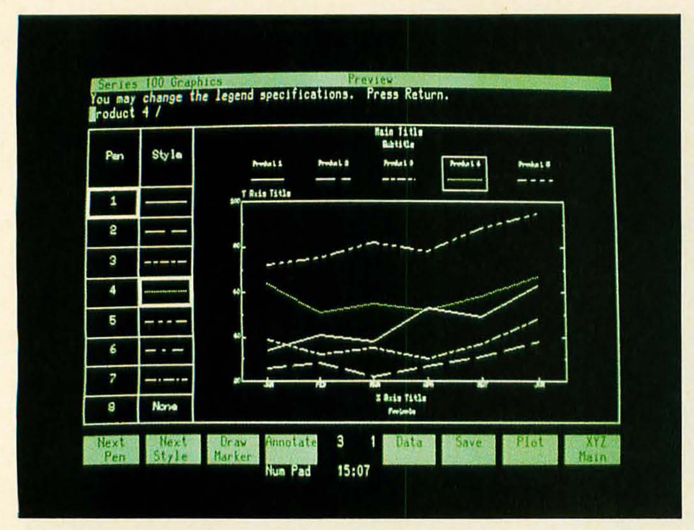


Photo 23: *Series 100 graphics from HP use touch to select pen color, style, and the functions you see on softkeys.*

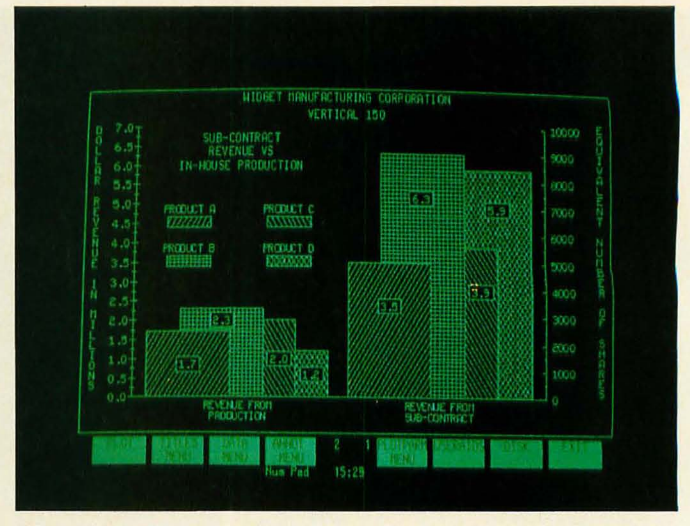


Photo 24: *A Picture Perfect bar chart demonstrates the high character resolution on the HP 150.*

dimensional appearance. Softkey menus can be used to define and adjust charts. Help messages contain key words that can be touched for additional help.

Diagraph can be used for flow diagrams, organizational charts, schematics, network design, slides, and presentation aids. Symbols on the screen help nonartists create sophisticated drawings. You can move, connect, and expand the symbols by touching the screen.

Communications and File Transfers

To use the HP 150 as a terminal for communications, simply boot up P.A.M., touch the Terminal softkey to access the four configuration menus, then, using touch or the keyboard, enter or change information to set a configuration.

Instead of typing configuration data, you can use touch to select data on the screen. For example, the "baud rate" prompt displays a new bit-per-second rate with each touch.

For file transfers, Hewlett-Packard offers the DSN (Distributed Systems Network)/Link program. DSN/Link can transmit both ASCII and binary data.

Transfers to the HP 3000 are easy and include error checking. Name the file you want to send or receive and initiate the transfer by touching the screen. Transfers to other computers require customization, but log-on procedures and repetitive commands can be stored in a file, and a softkey may be assigned for those files so they can be accessed by touch. Transfers to HP 120s, 125s, and 150s can be made without a host-computer connection. Transfers can be unattended, and the program includes automatic logging to disk and printers.

Data Transfer

When HP decided to offer popular software packages on the HP 150, the company worked on facilitating data transfer between them. Figure 1 illustrates the possible data transfers among Wordstar, Condor, Visicalc, Memomaker, PCF, and graphics. (Jim Sutton and John Lee explain how they accomplished data transfer on page 51.) The data transfer isn't as extensive as it would be in a fully integrated program designed for this purpose, but there is probably enough movement possible for most applications, and most transfers can take place using softkeys alone.

What Makes It Magic?

It's not just the touchscreen that makes this machine magical. It's the combination of ease of use, sophistication, and low price.

The decision to use a standard MS-DOS operating system means software houses can quickly modify their popular software packages for the HP 150. Users familiar with these programs can easily switch to touch. Novice users will find difficult programs are easier to learn with the touch interface.

The modification of applications to use a common user interface gives a cohesiveness and predictability to all the programs on the HP 150. P.A.M., HP's solution to the MS-DOS A> interface, gives new users a place to start and makes utility commands convenient for everyone.

But users who wish to can ignore the touchscreen in P.A.M., or any other features that don't appeal to them. Few, however, will ignore touch. Pointing to a spot on the screen is natural, and HP has paid careful attention to preventing accidental selection by touch. Mistakes are less likely than with a traditional system that uses keyboard keys to issue commands. Anyone can quickly begin using this system and its applications.

The HPTouch interface isn't flashy. It lacks spectacular effects such as desktops full of icons and overlapping windows. These omissions don't cause any sense of deprivation; in fact, they help achieve a simplicity that contributes to the system's elegance.

Although elegance can suggest formality that often signals "don't touch," the HP 150 invites us to touch. That makes the HP 150 as inviting as it is elegant. Certainly the HP 150 represents real progress toward the goal of putting high technology at the disposal of ordinary people.

—Barbara Robinson ■



An Interview: The HP 150's Design-team Leaders

by Phil Lemmons and Barbara Robertson

Jim Sutton and John Lee led the design team for the "Magic" personal computer system, now known as the HP 150. Sutton is a research and development section manager in the personal software division. Lee is a research and development project manager in the personal office computer division. Both talked to BYTE West Coast editors Phil Lemmons and Barbara Robertson at Hewlett-Packard's offices in Sunnyvale, CA.

BYTE: What are the most innovative things about the HP 150's hardware?
Lee: The touchscreen and the compactness. The touchscreen is not a new input device, but getting it into the box and lowering manufacturing costs took a major effort.
BYTE: How did you go about doing that?
Lee: We researched the touchscreen and did some preliminary models, trying to get it to work with very inexpensive standard LEDs and photodiodes.
BYTE: You used the optical approach because of inexpensive parts?
Lee: Well, the optical approach means we don't have to put a special film on the CRT that reduces the contrast and visibility. Also, with the optical approach, you usually don't have the radiation problems that you get with other types of signals going across the screen. We also made sure our design provides ways of loading the parts so that each individual cell doesn't have to be adjusted separately. That reduces our production cost.
Sutton: One of the other issues in selecting that particular mechanism for having a touchscreen was to make sure it would be at least as reliable as the other components in the system. Some of the technologies that we looked at early on didn't seem to promise that kind of reliability. With this particular technology, the touchscreen would not be the first point of failure in the system.
BYTE: How did you decide what resolution the touchscreen should have?
Lee: As far as resolution is concerned, it's really the pointing device's resolution that matters more than the screen's resolution. The sharper the pointing device, obviously, the more precisely you can point. A light pen can get close to a pixel

resolution, but we considered having to pick up a special device with a wire attached to it less friendly. So our resolution requirement was the end of a pencil. That was the smallest size we could deal with. Normally you deal with finger size, which is larger than pen size.

BYTE: Did you decide to use touch and begin thinking of how it might be used, or did you originally look for another input device?

Lee: We were really looking for a friendlier way of interacting with the computer. We had already used labeled softkeys on the screen that match a top row of function keys. The softkey labels could change when the keys changed their functions, but their use was limited by the keyboard.

Sutton: Originally, touch was an optional feature. Over the course of the development of the product, we convinced ourselves first of the value of touchscreen and second of our ability to manufacture it for a cost low enough to make the touchscreen a standard feature of the product.

We also had some customers directing us toward the touchscreen as an input device. HP has a partner's program in which we work with certain major customers in a very active role and reveal to them some of our future products with an agreement that they won't reveal them. In return, they give us some valuable insights into the products. Some of these customers played significant roles in deciding on the touchscreen's role in this product.

BYTE: Did anyone argue for eliminating cursor control or programmable function keys, forcing people to go through the touchscreen interface?

Lee: I think it was originally designed so that you were able to do anything from the keyboard because at that time the touchscreen was optional.

Sutton: Nothing restricts you from using the keyboard as the only mode of cursor positioning. Customers who choose to do coding might use the keyboard rather than the touchscreen mode. But in some applications—for example, on a shop floor—there might be no more than a couple of dozen possible input choices. Then it would be perfectly reasonable to put up the 24 possible choices so that someone wearing a heavy leather glove could poke at the touchscreen and use it as the total input system.

BYTE: What was the process by which you designed the keyboard?

Sutton: A group was formed to try and unify HP's planning for keyboards, and it did a thorough study on the ergonomics of the keyboard.

BYTE: How did you do that study?

Sutton: I understand it was done by reviewing all of the external studies that have been done as well as reviewing the ergonomic standards established and particularly the European standards.

Our resolution requirement was the end of a pencil—the smallest size we could deal with.

BYTE: According to the International Standards Organization?

Sutton: Right. We also did a lot of testing with a number of mock-ups that we built. The tilt and swivel features of the main unit are because of the same international ergonomic considerations.

BYTE: Does moving to a different part of the world affect the touchscreen?

Lee: There are differences as you move into the Southern Hemisphere, where the magnetic fields are different and affect the convergence on the CRT. After we have converged it and centered it for the Northern Hemisphere, there is a shift when we take it to South America. The user can realign the touchscreen by using one softkey that brings up an alignment grid on the screen.

BYTE: What are you aligning at that point?

Lee: There is a set of holes you can see on the side of the plastic bezel. That's where the light beams come through. We put a grid on the screen in graphics, and you position the whole graphic screen to align with the holes. In fact, that would probably be necessary in the Northern Hemisphere if you dropped the machine and the yoke at the back moved a little.

Sutton: Our production engineers in manufacturing have been quite concerned with making sure we had an adequate solution to this problem. The need for adjusting the screen has been minimized, but if it becomes necessary it's easy.

BYTE: What was the most difficult part of the hardware design?

Lee: The compactness, fitting everything into the box. That—and also meeting all the regulatory standards set up by FCC and DBE.

BYTE: DBE is the German equivalent of our FCC?

Lee: Yes. HP also has its own environmental standards to meet.

BYTE: Those are more stringent than the FCC standards, or unrelated to the FCC?

Lee: The FCC deals only with radio interference. We have standards dealing with shock test, transportation, and electrostatic discharge (so that if you are charged and touch the box, you will not cause the system to reset). Actually, the most important thing for any computer user is data integrity. We try to make sure that nothing that the user can do will cause loss or corruption of data. Every bit counts.

Sutton: You were asking about the keyboard earlier. In fact, although we get our key switches from a very good vendor, and the vendor does extensive testing, we subjected all key switches to millions of keystrokes with mechanical hands, off-center keystrokes with millions of repetitions, and so on. This testing identified some problems so we went back to the vendor and collaborated until we got solutions to those problems. That's fairly typical. Usually we have standards internal to HP that are higher than any of the standards that come from regulatory agencies.

BYTE: What did you have to do to get everything into that little box?

Lee: Well, there are some design trade-offs. For example, not using an 8086, which would require a 16-bit bus instead of the 8088's 8-bit bus. In

general, when you do logic design you have to pick parts very carefully to make sure you don't use too many SSI (small-scale integration) parts.

Also, you make sure that the chips will be in sync. The 8088 needs a lot of support chips, and the major functional chips must talk well to one another so you can massage the signals going from one to the other.

BYTE: What sort of a CRT is necessary to get the resolution so high on a 9-inch screen?

Lee: The CRT itself is not the major problem—it's the electronics that drive it, the discrete analog circuitry. We run at about twice the frequency that people normally run, so our analog circuitry has higher frequency response requirements. That usually creates the much higher resolution you see on the screen.

BYTE: The graphics are very fast. What did you do to make them that way?

Lee: There are both hardware and software factors. First, we have one gate array that handles our graphics display. Second, there is a careful design of the algorithms that do the graphics. We have a very strong graphics group that understands the algorithms of doing vector drawing, area fill, and so on.

BYTE: The gate array plays the role of a video-controller chip?

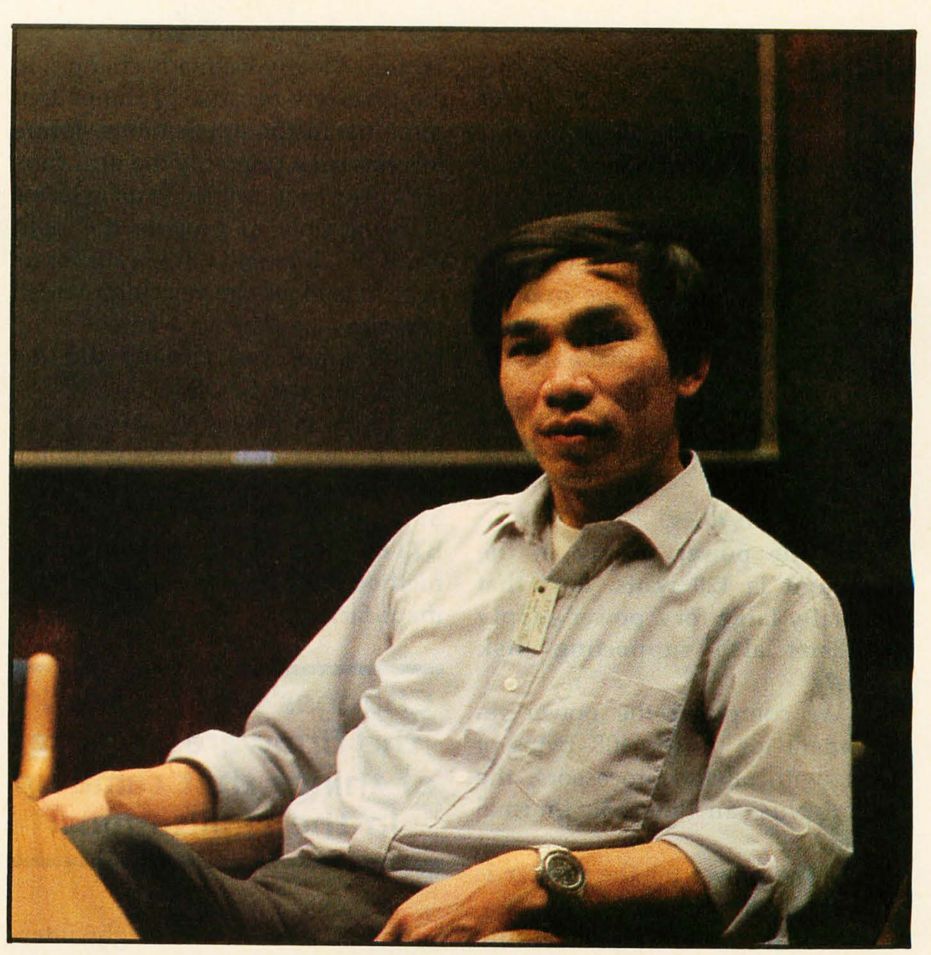
Lee: That's right, for the graphics.

BYTE: What about character-oriented I/O?

Lee: There's a separate controller. We have two planes, a graphics plane and an alphanumeric plane. A Standard Microsystems 9007 does the alpha control. It's a highly functional chip that replaces a lot of peripheral chips needed with the other controllers we have been using. The 9007 also does a lot of things itself without requiring the processor to support it. Even if the processor stops, the screen will not. The screen will be refreshed properly.

BYTE: Is some RAM (random-access read/write memory) dedicated to graphics storage, or is it all one continuous address space?

Lee: It's one continuous address space, but there are separate RAMs for the display because they need



John Lee, project manager for research and development in HP's personal office computer division.

much faster access. We use some static RAMs.

Sutton: One of the other things that makes graphics fast from an applications point of view is the additional level of interface to graphics that is accessible without going through some of the overhead associated with the operating system.

BYTE: The GIOS?

Sutton: That's right. The graphic I/O system allows an application using this level of interface to do so without incurring some of the overhead that would otherwise be necessary.

Lee: That software interface also has some other very important purposes. Most computers actually go directly to the hardware in order to enhance their performance. That poses a very serious compatibility problem in the future, because hardware will change. The GIOS and AIOS (alphanumeric input/output system) interfaces give you high performance but are software, so future products can be made compatible.

BYTE: Looking at other controllers, what microprocessor is in the keyboard?

Lee: I guess it would depend on what you call the keyboard. The keyboard itself has no microprocessor in it, just a few random logic chips. We use an 8041 on the main processor board to handle the touchscreen and the keyboard.

BYTE: Tell us a little bit about the HPIB (Hewlett-Packard interface bus) and how that affects adding peripherals to the system.

Lee: The HPIB has been accepted as an IEEE standard and we conform to it. That bus provides the flexibility to add a lot of peripherals through one connector in the main unit. You can just tie in the whole daisy chain without any restrictions, except for the electrical and loading restrictions. You can add disk drives and plotters and printers through the same bus.

BYTE: What CPU chips did you consider, and why did you choose the 8088?

Lee: The personal computer market tends to be mainly concentrated on the Intel processor family. The Intel family was chosen so we could run an industry-standard operating system. Other HP divisions are developing systems based on other processors, focusing on the Intel family.

BYTE: Will the hardware be an open system? Will you cooperate with companies that want to make add-on products?

Lee: Definitely.

BYTE: Does that apply to software as well?

Sutton: Yes, it does.

BYTE: The power supply in the main unit is 120 watts. Isn't that unusually large for a power supply that isn't also supporting disk drives?

Lee: We computed the power requirement for up to 640K bytes of RAM, with all the processors, the video, plus an internal thermal printer. . .

BYTE: The power for the printer is in there, too?

Lee: Yes. The power supply will support the printer and we have some left over for the option cards. In fact, some of the option cards could take quite a bit of power.

BYTE: Can you print the screen image at any time with this system?

Sutton: Yes, that's true, but with one caveat. It's really printing the internal memory image, not the screen, as you might expect. There are separate planes for graphics and alphanumerics, and, generally, you can print the normal alpha you see on the screen and the graphics you see on screen, but if you are seeing alpha on top of graphics with both planes displayed at once, you cannot get those printed out and overlaid correctly.

BYTE: What manages the HPIB and the serial ports?

Lee: The HPIB is managed by an HPIB controller chip from Texas Instruments, and the serial ports are managed by the NEC 7201 serial protocol controller.

BYTE: Did you make changes in hardware because of things that came up in the software? Jim, was there anything you asked John to do so that you could do something you were having trouble with?

Sutton: Clearly we made changes in the firmware because of things that came up in the applications. John's role has been primarily the firmware. He's been very helpful to us in terms of being able to provide the right kinds of AIOS and GIOS calls for us to be able to get the very high screen performance that we want.

BYTE: John, you actually did the AIOS and the GIOS?

Lee: A lot of people got involved in that because it involves everything from the operating system to. . .

Sutton: However, the answer's yes.

BYTE: What about manufacturing methods? Is HP active in automated manufacturing?

Changes were made in the firmware because of things that came up in the applications.

Sutton: We are increasingly interested, as are all companies, in this area, to both improve our quality and reduce our manufacturing costs through factory automation. If you walked out through the back room you would see some strange-looking robots making their way among the various devices.

We also have manufacturing representatives involved at extremely early stages in the design of any product like this, to make sure that the product is easily manufacturable with the kind of quality that we like to have associated with HP.

Lee: Manufacturability is an issue that's addressed on day one. It affects some of the things that we do—how the boards are laid out, where the holes are and how many screws we need, and other such considerations. Currently I would guess our most automated process is building the PC board. Production is automated and so is testing.

BYTE: You already have disk drives in different sizes that use the HPIB, so all the 3½-inch, 5¼-inch, and 8-inch drives are available for the 150 at its announcement?

Lee: Right, all those drives, the Winchesters and floppies.

BYTE: How compatible is the 150 with IBM PC software?

Sutton: Software that was written originally for the IBM PC is transportable directly into our environment so long as it doesn't depend on special hardware features of an IBM device and uses vanilla MS-DOS calls. If it does use vanilla calls, then it will work equally well with our vanilla MS-DOS. Of course, our graphics resolution is somewhat different, so things that are written to make specific use of our graphics may not be directly transported to the IBM PC. Conversely, things written to make use of special features on the IBM PC may not be directly transportable to the HP 150. People willing to make the effort of using special features in the IBM PC environment may well like to use the special features in our environment. For example, to be able to get the kind of screen performance that we have.

BYTE: Will you be offering a Winchester drive unit with the same form factor as the double microfloppy unit?

Sutton: Yes. Those units will be available at first shipment of the 150.

BYTE: Did you consider developing your own operating system with perhaps an iconic interface and bitmap graphics, with your own applications integrated into that?

Sutton: Yes. We did a significant investigation and a reasonable amount of work on our own interface and an operating system that provided some substantial additional features over MS-DOS. But we viewed access to software already in the marketplace as critical to the success of the product. We decided to use MS-DOS for that reason. We would like to provide an extremely wide variety of industry-standard software at the same time we provide another rich set of our own software, which will be more valuable than competitive products in the marketplace.

Lee: Users should not really have to be aware of what operating system the software is running under. What they're more concerned with is how they're interacting with the system,

and that's really through a shell or a program that's running on top of what traditionally is called an operating system. I think we achieve the added user-interface capability without having to change the standard functions that MS-DOS provides.

BYTE: How would you describe the operating-system architecture? Where does the touchscreen fit into that?

Lee: The touchscreen is just another device in the system.

BYTE: Handled the same way the keyboard is?

Lee: Handled similarly to the keyboard.

BYTE: Where do the AIOS and GIOS fit in?

Lee: You can view them as an extension of MS-DOS functions. What we want to do is design compatibility for future products at the operating-system level. MS-DOS is a standard operating system and changing it would make it nonstandard. But we still want to define a variety of new functions that a standard system cannot provide. So all the new functions fit within the MS-DOS definition. What we do is go through the I/O control path of MS-DOS system calls to access all the AIOS and GIOS functions.

BYTE: What is the AIOS?

Lee: In a nutshell, what AIOS does is replace what current systems do to write directly to video. That's the main goal of AIOS as far as output is concerned. We want high performance and multifunction capability to write to video and much tighter control of what people see on the screen. We provide that functionality while at the same time hiding all the hardware dependencies of the system. We defined a logical interface that can be transferred.

Sutton: You can think of AIOS and GIOS as being at a lower level than MS-DOS. They bypass some of the things that would normally go on in terms of typical device output in MS-DOS. At the same time, the AIOS and GIOS are in essence at a higher level because instead of being character-oriented in terms of its output, for example, they can deal with large blocks of text going to the screen at once. As a consequence, you can bypass many of the inefficiencies of the usual way of getting to the screen, and at the same time do things in large blocks of data rather than a character at a time. The net result is multiplicative, making the actual screen transfer rates very high.



Jim Sutton, section manager for research and development in Hewlett-Packard's personal software division.

Lee: The input our system allows is very important. In a standard system input is single-character-oriented; hit one key, and you get one character. That is very limited information. For example, the up-arrow key is a non-ASCII (American National Standard Code for Information Interchange) key, so you have no standard ASCII representation of it in one byte. To give the application better control of how the keyboard is actually used, you have to enhance input capability.

BYTE: How is transfer to the screen handled under the GIOS?

Sutton: There isn't blocking of data, but there are high-level operations such as polygonal fill and vector drawing. These are all handled as single operations, so logically you might consider that blocking of data. I can specify a polygon and fill it, and I don't have to send all the vectors to do the fill. A variety of fill patterns and line styles are all built directly in as GIOS functions.

Lee: Most operating systems are basically designed so that you have a computer and two wires talking to a terminal. You view console I/O as talking serially to a terminal outside of the computer, and that basically is a low-bandwidth path. We wanted a path whereby data goes out in a parallel fashion. The AIOS and GIOS achieve that.

Sutton: We can frequently write the entire screen in the blink of an eye. With that capability I don't have to wonder about algorithms that will rewrite the precise part of the screen that's changed. We've found that using the I/O structure simplifies a number of the programs that we do. For example, in our extended version of Visicalc, we don't write the whole screen; we're more intelligent than that. We write columns when the screen scrolls because we can write a column as a block on the screen. And we can do the things very rapidly. A trick we haven't made use of, but which I'm sure is awaiting exploitation in some future product from us or an outside vendor, is to make use of the two separate planes

of screen memory. If you are doing something in a graphics application and all your menus are completely active in the alpha plane, bringing up a menu just consists of turning on the alpha plane. This means you can fill an entire screen with a touchscreen menu instantaneously. And as quickly as the person touches the item of interest on the menu, the menu can disappear, leaving the graphics intact on the screen. The I/O structure suggests a number of novel uses.

BYTE: You did your work in Pascal. Did you consider other languages?

Sutton: Actually, we did consider and used other languages for that matter. We actively considered using Pascal from a number of independent vendors instead of the Pascal from the HP 3000 and considered using C as a language.

BYTE: Why did you choose Pascal over C?

Sutton: There are a variety of reasons. We like to get a great deal of the work done inside HP in a standard language so that it's easy to port around to other environments. For example, our Visicalc will be available on the 3000. And that's because we were able to write the program once. Then with changes to the I/O structure going to the screen, we were able to make that product run on both machines.

To be frank, we also wanted to have control over the quality of the language. If things turned out to be generating code that was too large for us, we knew we could go in and optimize the compiler.

Some of the utility programs in the system are written in C, but for utilities specific to the 150, it wasn't important to have a language with great porting capability. It made more sense to choose a language for other considerations, such as generating smaller or faster code.

BYTE: Is P.A.M. the utility that you're talking about?

Sutton: Part of P.A.M. was written in C and part in HP Pascal.

BYTE: Will you be able to write programs that use the touchscreen in any language?

Sutton: Any language can use touch already. There's nothing magic about touch. The touchscreen is controlled at the simplest level by escape sequences. I send those escape sequences just as if I were, if you will, printing them. And if I know what the escape sequences are, I read in my manual the escape sequences to activate a touch area at some certain area, then I can do that in any language.

BYTE: How did you decide what percentage of the resources, including memory, would be devoted to ease of use? How important was ease of use?

Sutton: We wanted to differentiate the 150 from other products in this marketplace, and ease of use was one of the critical differentiating factors, which is one of the reasons, of course, that we settled on the touchscreen.

It has always been our goal to use popular software packages and to develop some of our own.

We have a fairly formal procedure at HP for passing external specifications through a rigorous review process before the product is actually started. But I don't think we made a conscious decision during that process as to what amount of resources we would devote to ease of use. Our most important constraints, I think, are memory and disk size because we want everything to run on our smallest-capacity disks. Those are important constraints, and some ease-of-use features do take machine resources. For example, we wanted to prevent the possibility of invalid input. I think it's quite easy to enter invalid inputs and have the machine not object to them in some of the products we see on the market. The machine may not blow up, but it will do something that is inconsistent with the inputs. To us, ease of use is important in things as small as that to things as large as using the touchscreen. It all takes effort and code and size.

BYTE: Did you know from the beginning that you wanted to use popular software packages on your machine?

Sutton: Yes; that has always been a goal.

BYTE: When did you decide to also develop some of your own software?

Sutton: That's always been involved in the machine also.

BYTE: To what degree do the applications transfer data among them?

Sutton: We have modified existing applications or worked with vendors to modify the applications to use the high-speed I/O and touchscreen features, and also, in a more limited way, to have the ability to move data back and forth. We've often reworked our own applications to facilitate the data transfer. For example, our own card-file package has been tested to make sure that its data can be transferred to and from the Condor database package. In the same way, we've made sure that our own Memomaker editor is able to transfer data between itself and word-processing packages from outside vendors. We facilitate the transfer by using outside vendors' file formats directly or by having easy ways to get between our format and theirs.

BYTE: You can move information between the Personal Card File and Condor and between the Personal Card File and Wordstar's Mailmerge program. Did you try for greater data transfer?

Sutton: Yes. Our inability to do a greater degree of data transfer is in some sense a limitation of MS-DOS. One reason we thought about building our own operating system was that we knew that with it we could give the appearance of integrating separate, independently written programs. We may yet be able to accomplish that through other mechanisms or through future releases of MS-DOS.

To transfer data among our own applications, we have a mechanism that might be considered similar to Unix pipes.

BYTE: What functions does the file manager provide for applications?

Sutton: Well, fundamentally, it provides consistency across all applica-

tions, whether in-house or proprietary. The user has a consistent way to get at data and files on the system. So, for example, using the file manager, a person can readily view any directory on any disk, see that directory sorted in alphabetic order, and by simply pointing to a file cause that file to become the object of interest to the application. In addition it provides more functions—in fact, better functions—than conventionally available in packages like Visicalc or our previously existing graphics packages.

BYTE: How did you decide what enhancements to add to Visicalc?

Sutton: We looked at a number of spreadsheet packages that are available in the marketplace today, including the Advanced Visicalc package. Then we compiled a prioritized list of features we would like to see in the package. From that list we chose the features that we could accomplish in the time frame that we had for the product. We expect to continue adding important extensions to Visicalc. Our special interest right now is how to tie spreadsheet packages to a larger network environment.

BYTE: How did you speed up software written in high-level languages?

Sutton: Our approach has been to develop the languages in a fairly straightforward approach in the 3000 environment and to bring those languages across to the 150. We used the results of that as a basis for analysis on where we could tune and improve performance. First and most obvious was to modify all the I/O to use the AIOS/GIOS to improve performance. In addition, monitors tracked time we spent on particular blocks of code. We used this to determine where, for example, our run-time library might need to be optimized to make it faster. Sometimes the compiler itself needed to be optimized in some ways. Sometimes we could change our coding practices and make use of particular algorithmic features. For example, our first version of Visicalc wrote the full screen in MS-DOS vanilla screenwriting. Our second version of Visicalc wrote the full screen using AIOS. The third version would rewrite only the column that would move the whole screen over and then write only the new column, both of which are AIOS functions.

BYTE: You've been working with lots of independent software vendors. Do you have a mechanism in place for looking at proposals from ISVs (independent software vendors) and from independent, one-man programming firms that want to write for the HP 150?

Sutton: We have a mechanism in place and a better one will certainly be on the way by the time this article appears. We are doing two things simultaneously. One is actively soliciting all the vendors of top software packages in the marketplace,

A special interest is how to tie spreadsheet packages to a larger network environment.

and the second is being receptive to the ideas of smaller vendors who desire to participate. At the moment, we have an ISV cookbook that helps vendors use all the features we've described. We also offer vendors technical support and the physical hardware.

In the future we will have parallel R&D and marketing activities: a complete R&D lab within the personal software division, whose entire orientation is toward helping ISVs develop software for this machine, and a parallel marketing organization helping from the marketing side.

BYTE: What was the hardest part of the whole project?

Sutton: The hardest part of the whole project for me was the fact that a lot of things that are normally done serially were being done in parallel. There were huge numbers of critical and interrelated decisions going on at once.

BYTE: When were you convinced it would really work as you had imagined it would all work?

Sutton: I'm a true believer; I always believed it would. The only variable was the time.

BYTE: Did this project start before or after the consolidation of the personal computer division?

Lee: Before.

BYTE: And is this the first project of that division, or is this a project the division inherited?

Sutton: In a sense the division inherited it, but I think that the notion of the project was one of the things that caused the organizational restructuring of the company. I think that trying to decide your placement in the marketplace goes a long way toward dictating the structure of your organization, and that was true here.

BYTE: Was there a specific group of people who worked throughout the project, or were people pulled in and out of the Magic team?

Sutton: It was a little bit of both.

BYTE: How many people have worked on this project?

Sutton: About 50 R&D people are working on it now.

BYTE: Did people take the machine home to continue work, or did you keep it pretty well locked up?

Sutton: Lately people have been taking it home to work on. I know I took it home. My kids had a wonderful time playing with it. We will achieve great penetration in the 4- to 7-year-old market as well as in the business market.

BYTE: Was there a kernel of the team, a group of people who've been working only on this who will go on to another project as a team?

Lee: Not necessarily.

Sutton: I think in the software area that will probably be true. Our view of the software area has a longer range than this particular set of hardware. One of the purposes of forming the personal software division is to have compatible, consistent software across a range of products, both the products that are available now and in the future.■

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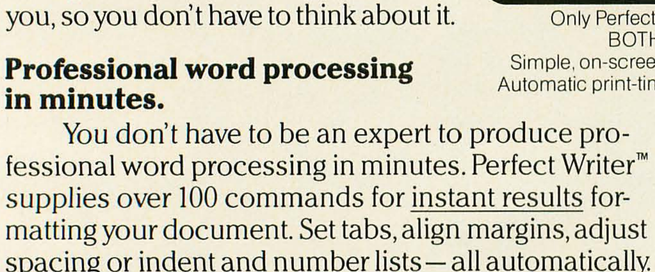
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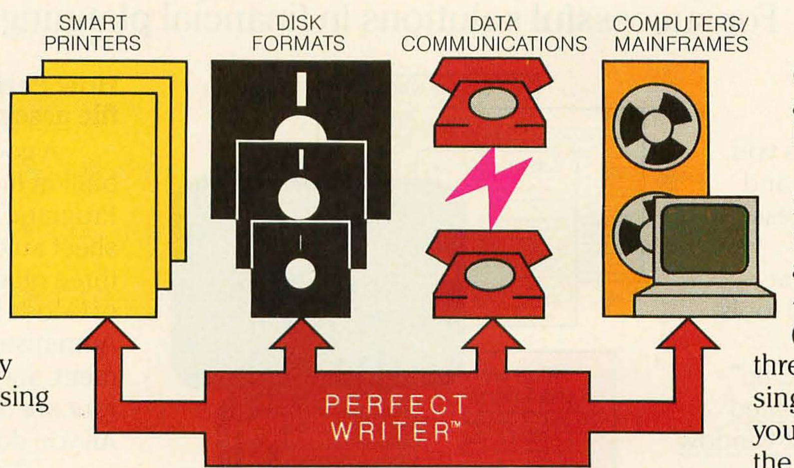
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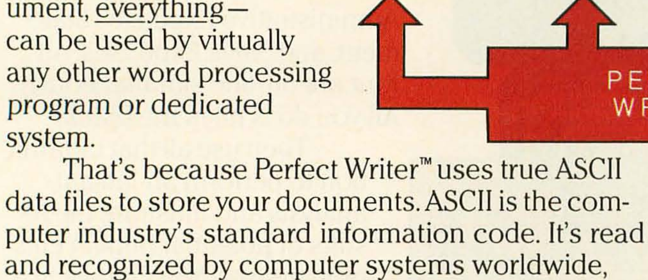
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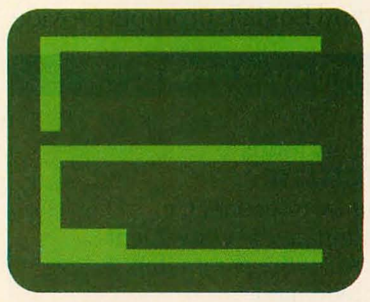
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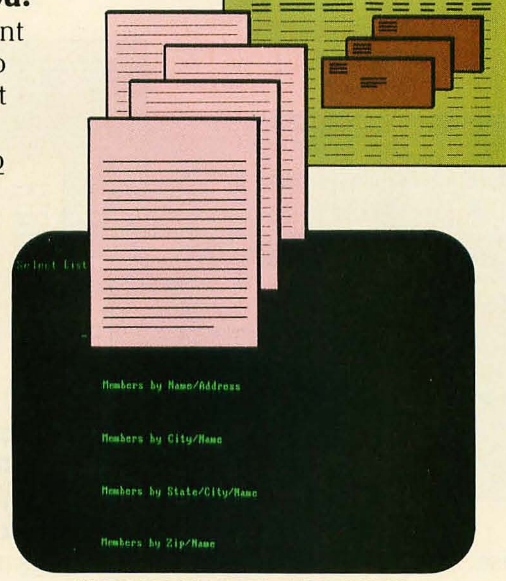
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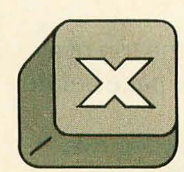
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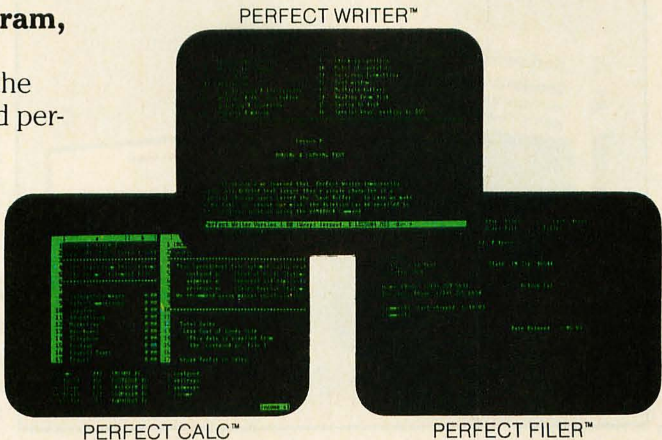
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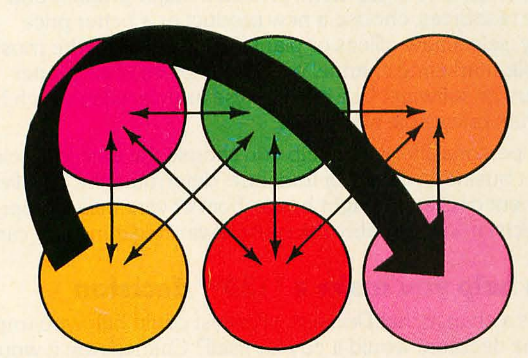
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Build the Micro D-Cam Solid-State Video Camera

Part 2: Computer Interfaces and Control Software

Serial interfaces for the Apple II and the IBM Personal Computer and versatile software for the Apple II

by Steve Ciarcia

Last month I introduced you to the Micro D-Cam, a relatively low-cost direct-output digital camera that you can build, either from scratch or from a kit distributed by The Micromint. Using a 64K-bit dynamic memory chip as its optical sensor, it has a resolution of 256 by 128 pixels (picture elements), which is adequate for many applications, including input of graphic images, pattern and character recognition, robotics, process control, and security.

In part 1 I explained the principles of operation of the IS32 Optic RAM (random-access read/write memory) and the rest of the Micro D-Cam's hardware. (Table 1 may help you recall some of the IS32's characteristics.) This month I'd like to finish the project by discussing how the camera can be attached to the expansion buses of the Apple II Plus and the IBM Personal Computer and how the camera is programmed to work.

The amount of software included with this article is somewhat more than you've come to expect from a hardware-type fellow like me, but I feel it is necessary to properly show how software can be used to enhance the final picture. In particular, some of you may be interested in the method used to present a gray scale on an Apple II computer.

A Quick Review

The IS32 Optic RAM from Micron Technology Inc. is a memory chip specially packaged to function as a digital image-sensing device. (Because its output is a pure digital signal, it cannot be used to directly drive a composite-video monitor.) The IS32 contains 32,768 usable light-sensitive elements arranged in a matrix of 128 rows and 256 columns. Each of the elements in the matrix is a light-sensitive capacitor, a memory cell that can be accessed randomly by simply reading in the appropriate row and column address. Light striking a particular element causes the capacitor, which is initially precharged to a fixed voltage, to discharge toward 0 volts (V). The capacitor discharges at a rate proportional to the light intensity throughout the duration of the exposure. When the cell's content is read, a logic 0 remaining in the cell indicates a bright pixel—the capacitor was exposed to a light intensity sufficient to discharge the capacitor past the threshold point. A dark pixel is indicated by a logic 1 remaining in the cell, which happens when the light intensity is not sufficient to discharge the capacitor past the threshold point.

1. two 128- by 256-element arrays each measuring 5.504 by 1.088 millimeters
2. element size: 8 microns by 9 microns
3. vertical center-to-center spacing: 21.5 microns
4. horizontal spacing: 8.5 microns
5. spacing between left and right arrays: 150 microns

Table 1: *Specifications of the Micron Technology IS32 Optic RAM, a 64K-bit memory chip that has the extra talent of serving as a digital image detector.*

The operation of the image sensor can be compared to the function of film in a camera. The user can regulate the exposure by two adjustments: aperture (f-stop) and shutter speed. The aperture adjustment controls the amount of light that is allowed to expose the light-sensitive medium (either the IS32 or the film emulsion) by mechanically widening or narrowing the hole through which the light passes. The shutter speed (or scanning speed in the case of the IS32) dictates the amount of time the sensitive medium is exposed.

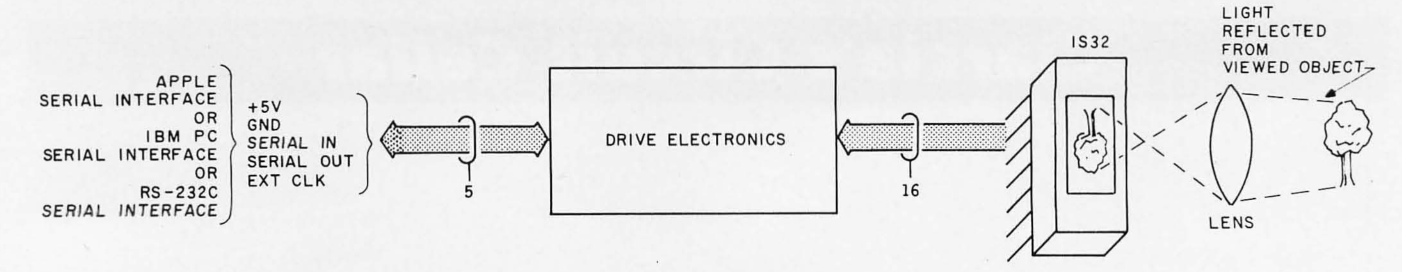


Figure 1: *A block diagram of the Micro D-Cam system.*

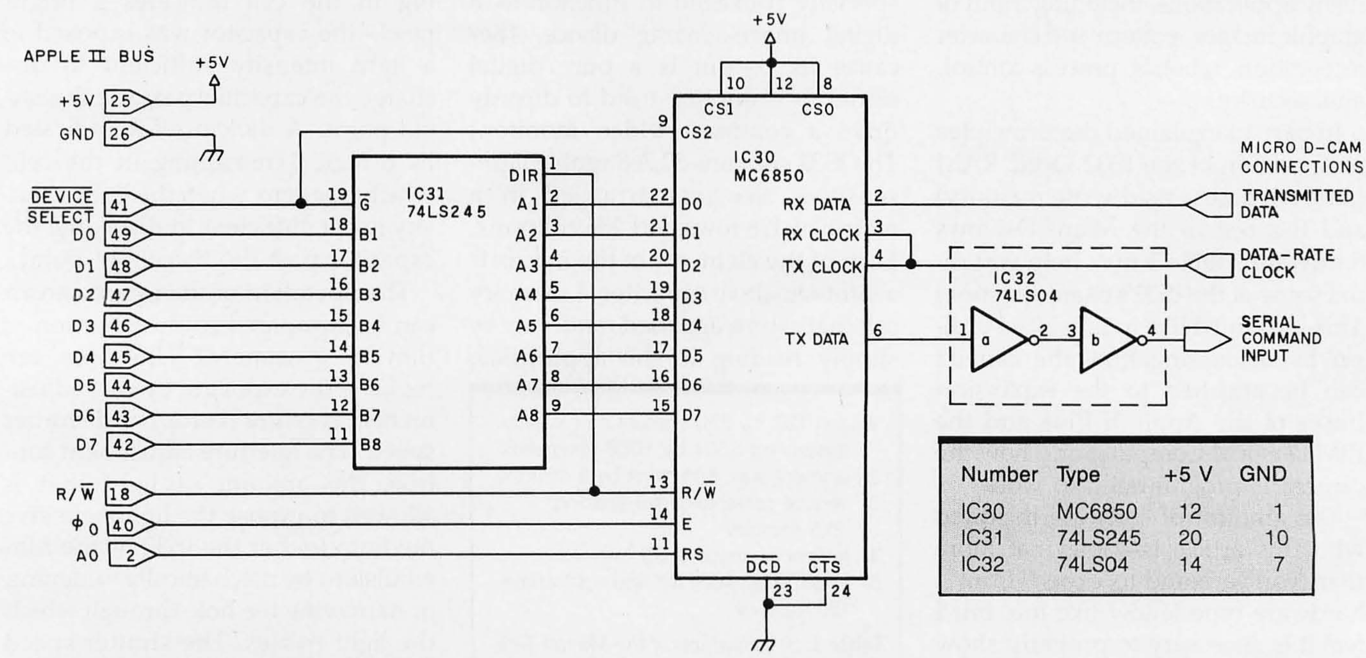
The Micro D-Cam's equivalent of an electronic shutter is controlled by commands transmitted to the interface. Sending a SOAK command to the Micro D-Cam has the effect of opening the shutter. After the appropriate period of exposure has elapsed, two commands, REFRESH and SEND, stop the exposure (close the shutter) and transmit the image to the host computer.

Interfacing the Micro D-Cam

Last month, when we looked at the control and driver electronics of the basic Micro D-Cam, we found that it communicates with its host computer serially, one bit at a time. In its minimal configuration, it requires four wires to be connected to the host computer: two supplying +5 V and ground potential and one each for serial data in and out. In a nonspecific configuration, it can operate asynchronously over an RS-232C link (at a data rate of up to 19,200 bps or bits per second), but I have devised serial interfaces for the camera that can be attached directly to the IBM PC and Apple II computers' buses (although still communicating serially). Using a fifth signal, an additional external clock signal provided to the bus interfaces by the drive electronics, the Micro D-Cam can then function at data rates up to 153,600 bps. The complexity of interface circuits of this type depends upon the host computer's bus structure and address range. The general scheme of connection is shown in figure 1.

Figure 2 is a schematic diagram of the circuit that forms the interface from the Micro D-Cam circuitry (shown in part 1) to the expansion bus of the Apple II Plus computer. It owes its simplicity to the predecoding of the I/O (input/output) slot address already provided on the Apple's main circuit board. The address decoders usually required in a peripheral interface are eliminated, and the complete serial interface can be built with only two integrated circuits. The 74LS245 octal bus transceiver buffers the TTL- (transistor/transistor logic) level serial data into and out of the MC6850 ACIA (asynchronous communication interface adapter). The serial bit rate is controlled by the external clock output from the Micro D-Cam drive electronics. For maximum speed, the clock frequency should be set for 153,600 Hz.

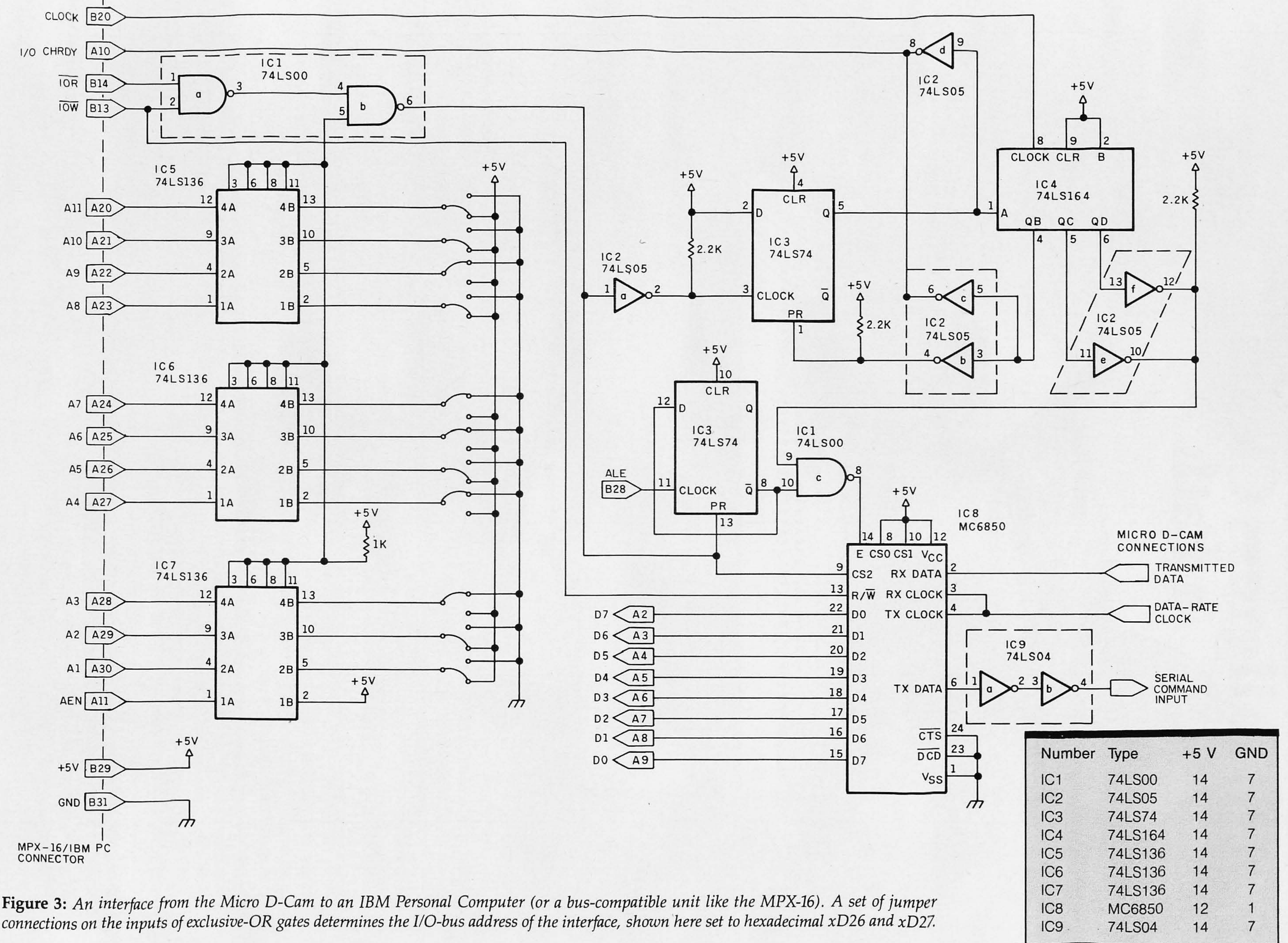
Figure 3 on page 70 shows the serial interface circuit for the Micro D-Cam configured for the IBM PC's bus. Due to the greater complexity of the Intel 8088 processor as compared with the Apple's 6502 and the PC's larger memory-address space, the in-



Number	Type	+5 V	GND
IC30	MC6850	12	1
IC31	74LS245	20	10
IC32	74LS04	14	7

Figure 2: *A schematic diagram of an Apple II Plus or Apple IIe interface for the Micro D-Cam. The serial data stream from the Optic RAM is converted to parallel bytes and placed on the Apple's data bus by the ACIA and bus transceiver. Although operating asynchronously, high data rates (up to 153,600 bps) are possible because of the external data-rate clock input from the camera-control circuitry.*


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Number	Type	+5 V	GND
IC1	74LS00	14	7
IC2	74LS05	14	7
IC3	74LS74	14	7
IC4	74LS164	14	7
IC5	74LS136	14	7
IC6	74LS136	14	7
IC7	74LS136	14	7
IC8	MC6850	12	1
IC9	74LS04	14	7

Figure 3: *An interface from the Micro D-Cam to an IBM Personal Computer (or a bus-compatible unit like the MPX-16). A set of jumper connections on the inputs of exclusive-OR gates determines the I/O-bus address of the interface, shown here set to hexadecimal xD26 and xD27.*



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Circle 525 on inquiry card.

(2a)	Status Bit	Meaning When Set to 1
	0	data has been received from the camera
	1	a command may be sent to the camera
	2	unused
	3	unused
	4	received data was improperly framed
	5	data received before previous byte read

(2b)	Command Bit	Meaning When Cleared to 0
	7	none (always 1)
	6	none (always 1)
	5	alternating-bit mode (ALTBIT)
	4	wide-pixel mode (WIDEPIX)
	3	7-bit data bytes (7BIT)
	2	transmit one frame instead of two (1ARRAY)
	1	refresh instead of soak (REFRESH)
	0	send the requested image (SEND)

Table 2: *Meanings of bits in the status register (2a) and command word (2b) for the Apple II/Micro D-Cam interface.*

terface requires three times as many integrated circuits. In the IBM, the Micro D-Cam's two port addresses are decoded by three chips: IC5, IC6, and IC7. These are 74LS136 open-collector exclusive-OR gates connected together in a "wired-OR" configuration. The voltages wired to the 11 inputs of the address decoder determine the interface board's addresses. As shown in figure 3, the addresses I used were *x*D26 and *x*D27 (where *x* can take on any hexadecimal value from 0 to F). The 6850 ACIA (IC8) functions as previously described except that IC2 and IC4 are configured as a wait-state generator to facilitate timely access to the bus.

Data and Command Format

The 6850 ACIA comprises a data register and a status register. You can configure operating parameters (such as parity, stop bits, start bits, clocking, etc.) by writing values into the status register. Before the host computer can access the Micro D-Cam, the ACIA has to be initialized to the proper configuration. The control software does this by writing two bytes, a hexadecimal 03 followed by a hexadecimal 14, into the status register. The first byte performs a master reset on the ACIA, while the second byte specifies that the serial transmission protocol is 1 start bit, followed by 8 data bits, followed by 1 stop bit.

Reading the status register allows the control program to determine when new data has been received and when the ACIA is ready to send data. The meanings of the status bits, when set, are as shown in table 2a.

In normal use, only bit 0 is checked when seeing if data is available from the camera. Bits 4 and 5 are used only in debugging, as these situations should not normally arise. When designing the program that receives the image from the camera, it is a good idea to incorporate a time-out mechanism in case the camera stops sending bytes before the program expects; otherwise, the program can hang up if the software misses even a single byte.

In the Apple II Plus and IIe, the hexadecimal addresses of the type C0*n*E access the status register of the ACIA on an interface card plugged into the corresponding slot, while C0*n*F addresses access the ACIA's data register. The *n* is the hexadecimal value of the slot number plus 8. For example, suppose the interface card were plugged into slot 3; 3 plus 8 equals B, and so address C0BE will access the status register and C0BF the data register.

Command Functions

While the camera is running, the host computer directs the Micro D-Cam's operating modes by sending it command words. Each command word is composed of 8 bits, with functions as summarized in table 2b. Let's look at each of these in detail:

ALTBIT Mode: When bit 5 is clear (equal to 0), the Micro D-Cam transmits only the pixels from the even-numbered rows and columns in the Optic RAM. This mode usually produces a clearer image than the NOALTBIT mode at the expense of losing resolution.

WIDEPIX Mode: When bit 4 is clear, the Micro D-Cam transmits each pixel in the array twice. Each image-sensing element is *rectangular* in shape, so by "double-transmitting" the pixels, the proper width-to-height (aspect) ratio is maintained when the image is displayed on the computer's video monitor.

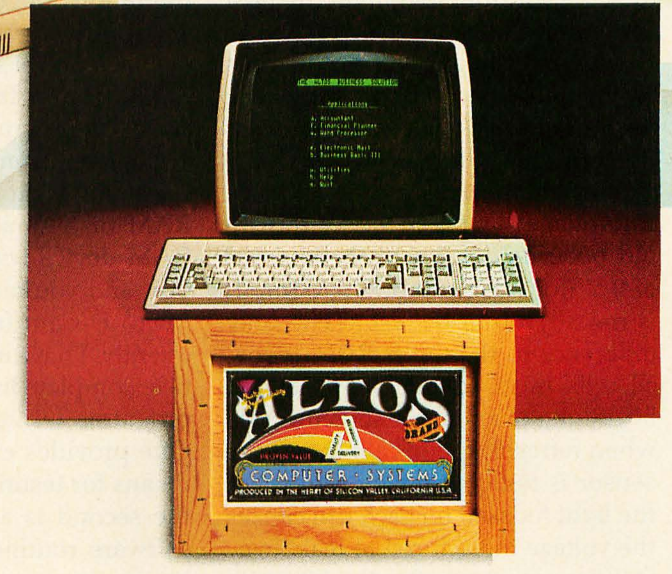
7BIT Mode: The Apple II's implementation of high-resolution graphics is somewhat peculiar. The most significant bit of each byte on the hi-res graphics page is reserved as the color bit for a group of pixels, while each of the other 7 bits stores a 1 or 0 as a bright or dark value for a pixel. In 7BIT mode, the Micro D-Cam transmits data in a format compatible with the Apple's high-resolution format, with 7 bits of pixel values per byte. The 7BIT mode is selected by clearing bit 3 of the command byte to 0. The alternative to 7BIT mode is 8BIT mode, which is achieved by setting bit 3 to 1. The 8BIT mode causes the camera to transmit in normal bit-mapped format, with all 8 bits in the byte containing image data, and is preferred for use with all computers other than the Apple.

1ARRAY Mode: The 1ARRAY mode is selected by clearing bit 2 of the command byte. Using this mode, only data from the image focused on the lower light-sensitive array is transmitted from the Micro D-Cam. By setting bit 2 of the command byte, 2ARRAY mode is selected, which causes data from both arrays to be transmitted from the camera. The 2ARRAY mode causes a split-screen effect because of the space between the two arrays in the image-sensor chip.

REFRESH Mode: In some ways, the Micro D-Cam is like any other

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ALTOS COMPUTER SYSTEMS

Circle 30 on inquiry card.

Command Character	Control Effect
>	increase exposure time
<	decrease exposure time
F	fix exposure time to current setting
L	load previously stored image from disk
N	print negative of screen image onto Epson printer
P	print screen output onto Epson (Graftrax option required)
Q	quit and return to main menu
R	toggle display of exposure time and light level
S	save current image to disk
T	use current light level and autotrack the exposure

Table 3: *Options for control of the Micro D-Cam that may be selected in real time through the distributed menu-driven software. See table 4 for the options provided in the GREY16 program.*

camera. It must receive the proper amount of light to make the image develop properly. Too much light will overexpose the image, while too little light will underexpose the image. Exposure time is determined by how long the control program in the host computer allows the Optic RAM to be exposed to light without its cells being refreshed. Refreshing the image sensor is the same process used in any dynamic memory: the existing charge in each cell is sensed, the voltage compared with a threshold potential, and a fresh potential of 0 V (for a logic 0) or +5 V (for 1) is rewritten into the cell. (The only difference in the Optic RAM is that all cells must contain +5 V at the beginning of an image-sensing cycle when refreshing stops.) If the image sensor is not continually refreshed, the light focused on each cell causes the voltage in each cell to leak away at a rate proportional to the intensity of the light. When the image sensor is not being refreshed, we say it is "soaking" (in light). Allowing the image sensor to soak for longer periods of time enables the Micro D-Cam to see better in dimmer light.

When the REFRESH mode is selected (by clearing bit 1 of the command byte) the Micro D-Cam keeps the image sensor's cells refreshed while it is sending an image. When bit 1 is set, SOAK mode is invoked. This causes the camera to soak (and therefore remain sensitive to light) while it is transmitting an image.

SEND Mode: When a command is sent to the camera with SEND mode selected (bit 0 cleared), the camera begins transmitting an image.

Control Software

The software for controlling and displaying pictures is vital to the operation of the Micro D-Cam. Menu-driven versions of the Micro D-Cam control software for both the Apple II and IBM PC are available from The Micromint.

However, some of you may already have the Micron Technology Optic RAM or a similar 64K-bit dynamic RAM device with suitable chip layout, and you may want to build the Micro D-Cam from scratch. Consequently, I have included with this article complete listings of two control programs written for the Apple II. One provides experimenters with a means for testing the Micro D-Cam; the second is a more sophisticated software routine that enhances the image and performs gray-scale ordered dithering (I'll explain this term later). While the Micro D-Cam software includes some additional menu-driven utility programs (some options of which are shown in table 3), all the Micro D-Cam photos printed here and last month can be reproduced using only the two programs in the magazine.

A Sample Control Program

The Micro D-Cam demonstration program (listing 1 on pages 512 through 518) illustrates the simplest possible software needed to receive an image from the camera and display it on the Apple's hi-res screen. It is not really as long and complicated as it looks; the accompanying flowchart (figure 4 on page 76) should reveal the general scheme of operation. The software consists of two parts: a short BASIC main program (listing 1a) and a set of machine-language subroutines (shown in assembled format in listing 1b). The BASIC program loads the machine-language code from disk, interactively sets the correct I/O-slot number and exposure time, and calls the machine-language code to display the image; upon returning to BASIC, the calling program checks to see if you want to terminate the process.

The hard part of the work is done in the machine-language routines, which were necessary to allow the Micro D-Cam to operate at 153,600 bps. When called, the machine code begins by making sure that the hi-res screen is being displayed. It then initializes the ACIA and sends a command to tell the camera to soak without sending an image. (This effectively clears the Optic RAM and tells the camera to begin the exposure.) The program then waits for the duration of the exposure.

The next step is to read the image from the camera and display it on the screen. To save time and memory, the software sends the picture straight to the hi-res screen memory (rather than reading it into a separate buffer area and then moving it) to minimize the processing of the final image. The mode used is alternate-pixel, wide-pixel, with 7-bit data words. Before any part of the picture is received, a number of memory pointers are set up to facilitate proper placement on the screen. A command is sent to the camera to begin transmitting the image, and the program loops to read in each byte of the image and put it on the screen.

The control software knows how many bytes of image data it should receive from the camera, but a problem can arise from relying on byte-counting to determine when to stop reading data: if the computer misses one, it could hang the system up. To be on the safe side, a time-out loop has been provided in the image-reading routine. If the computer times out

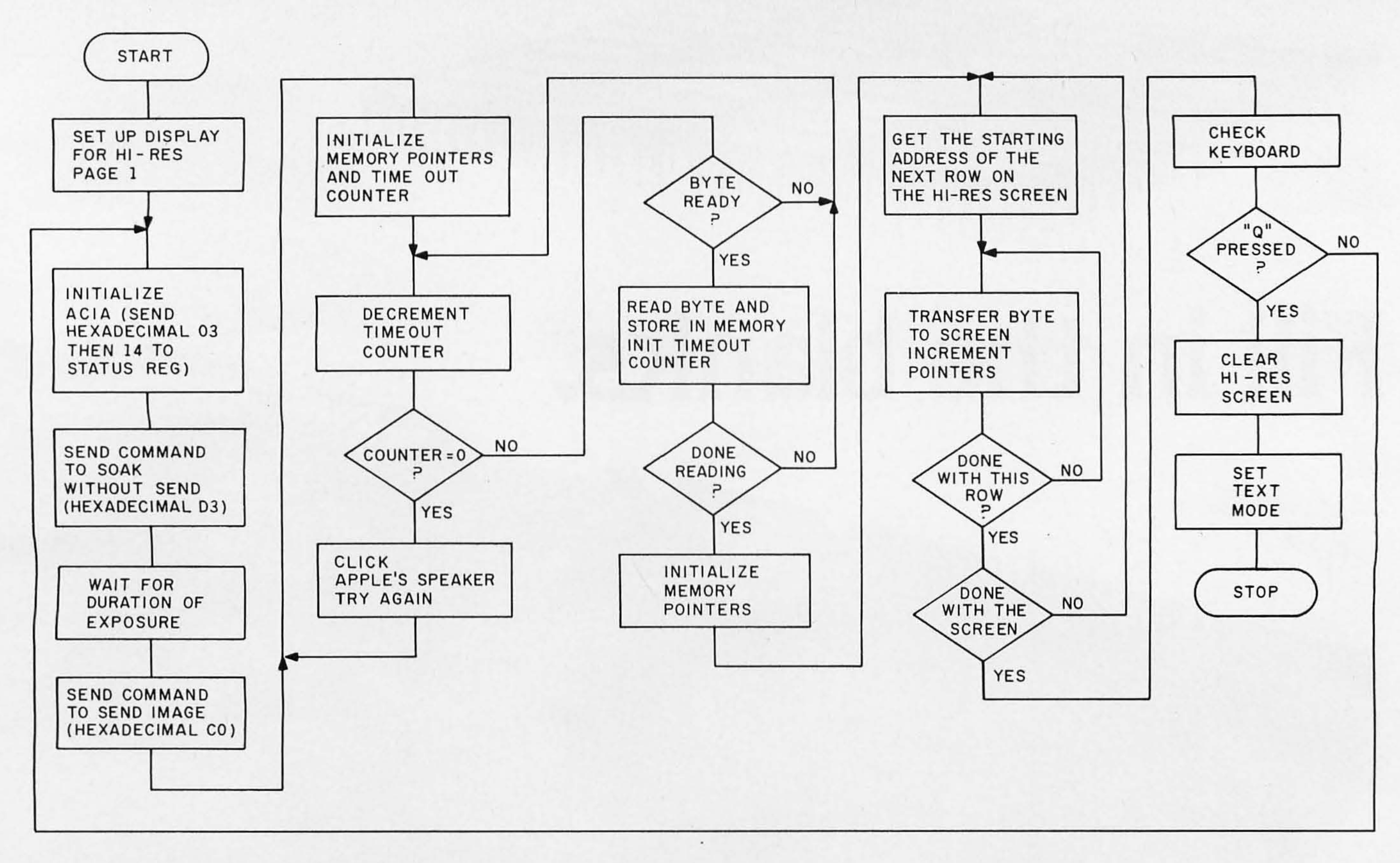


Figure 4: *A flowchart of the Micro D-Cam demonstration program for the Apple II. The program consists of a BASIC main routine, shown in listing 1a, and some 6502 machine-language subroutines, shown in assembly-language form in listing 1b.*

while waiting for the camera, it clicks the speaker, checks for a keypress, and tries the entire command sequence again. In this manner, you are alerted to any possible problems.

Because the Apple's hi-res screen display is mapped nonlinearly into memory space, a lengthy table at the end of the machine-language code provides the starting address for each consecutive row of the hi-res screen. The program gets the address of the beginning of each row and then reads 40 bytes from the camera, placing them consecutively on the screen. The next row, and each row after it, is done in a similar manner.

Once the image is on the screen, a command is sent to the camera to refresh without sending. This gets it ready for the next exposure. Finally, the machine code checks the keyboard and processes any command inputs before returning to BASIC.

Obtaining Gray Scale

A more user-friendly demonstration of the Micro D-Cam that also provides a level of gray-scale capability is the GREY16 program of listing 2 (pages 518 through 538). It has one mode that allows you to do quick aiming and focusing of the camera, another to let you get an idea of what the final picture will look like, and a third to create a 15-intensity-level gray-scale picture on the Apple II. (The processes involved are outlined in the flowchart of figure 5. Unfortunately, space constraints prevent me from showing you a similar program for the IBM PC.)

Using GREY16, you can change the length of exposure for the image being displayed, or you can change the upper and lower exposure limits of the gray-scale image. Once you've obtained a satisfactory picture, you can save it on disk for later use or print it on an Epson MX-80 printer (equipped with Graftrax) using the screen-dump program. A summary of available commands in the GREY16 program is shown in table 4.

When it is first powered up, you start the camera running by selecting one of the options from the GREY16 menu. If the exposure time is insufficient, the screen will be black. If the exposure time is excessive, the screen

Text continued on page 82

Command Character	Control Effect
N	display the image in normal size (256 by 64)
F	display the image in full size (256 by 128)
G	create a picture (256 by 128) with 15 levels of gray (this process takes about 30 seconds and displays a countdown of the number of exposures from F to 0)
E	change the exposure time of the current displayed image, the upper limit of the gray-scale image, or the lower limit of the gray-scale image
S	save to disk the picture currently being displayed (this may be done in any of the three display modes: normal, full, or gray)
Q	quit the program and return to BASIC

Table 4: *A summary of user commands implemented in the GREY16 program of listing 2.*

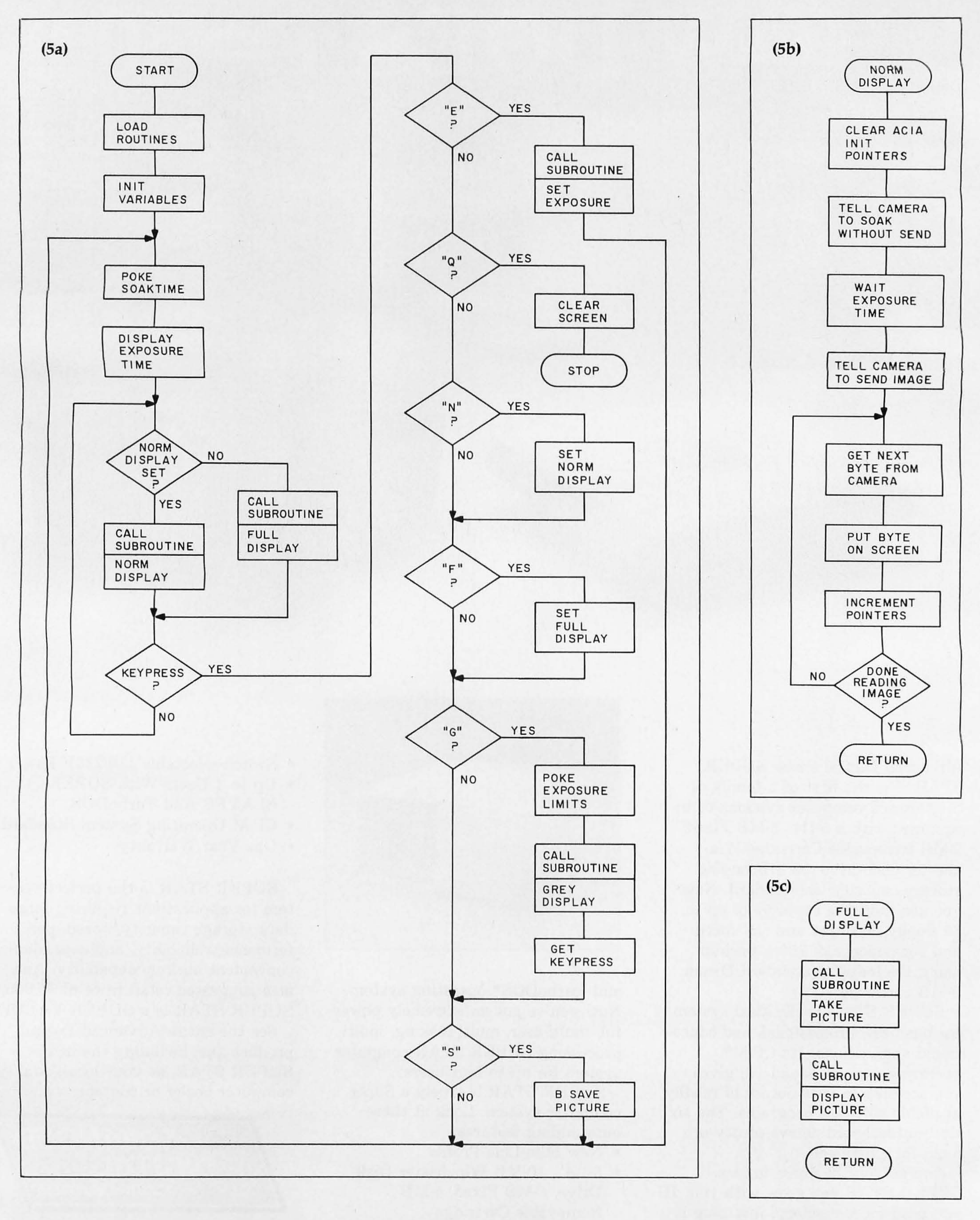


Figure 5: *Flowcharts of the GREY16 program for the Apple II (the figure continues on pages 80 and 82). The BASIC portion appears as listing 2a, the machine-language portion as listing 2b. The main routine (5a) calls various subroutines: NORM DISPLAY (5b), FULL DISPLAY (5c), SET EXPOSURE (5d), GREY DISPLAY (5e), TAKE PICTURE (5f), DISPLAY PIC (5g), and ENHANCE (5h).*

The subroutine GREY DISPLAY takes sensor pixels from 15 exposures and translates them into arrays of the smaller display pixels to represent intermediate brightnesses.

Figure continued on page 80

From Computer Plus to YOU . . .

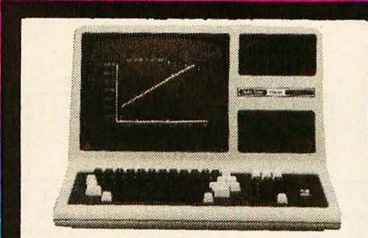
PLUS after PLUS after PLUS



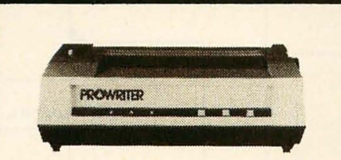
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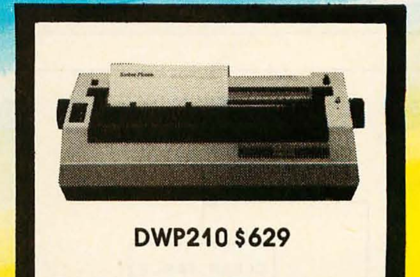
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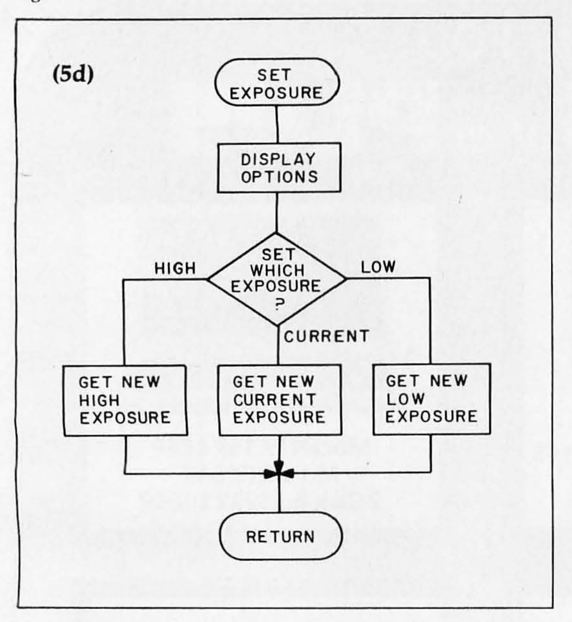
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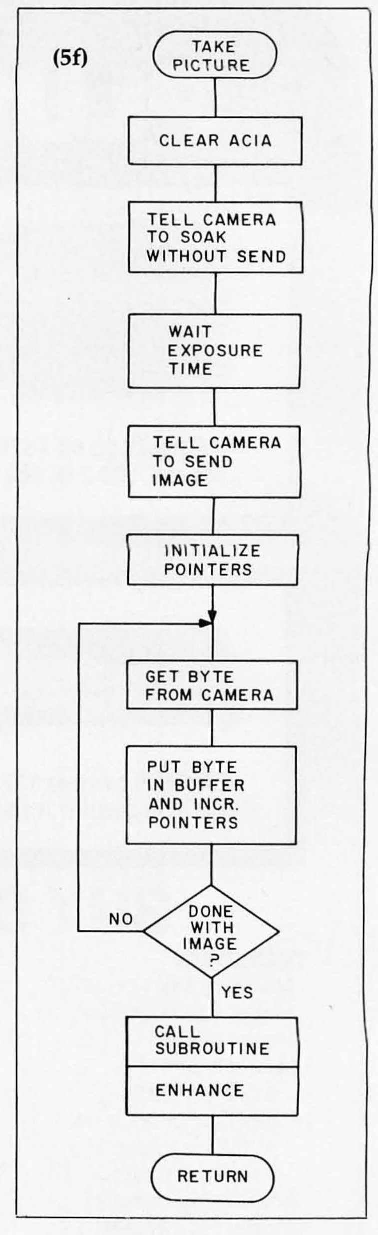
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Figure 5 continued:





(5e)

GREY DISPLAY

CLEAR TABLE

PRINT COUNTDOWN

CALL SUBROUTINE

TAKE PICTURE

NEXT PIXEL ON ?

NO

YES

INCREMENT PIXEL'S COUNTER

DONE WITH THIS PICTURE ?

NO

YES

ADD INCREMENT TO SOAKTIME

DONE WITH 15 PICTURES ?

NO

YES

INIT POINTERS

GET THIS PIXEL'S COUNT

IS COUNT GREATER THAN VALUE IN DITHER MAT.

?

NO

YES

TURN ON PIXEL

INCREMENT POINTERS

DONE WITH IMAGE ?

NO

YES

CALL SUBROUTINE

DISPLAY PICTURE

RETURN

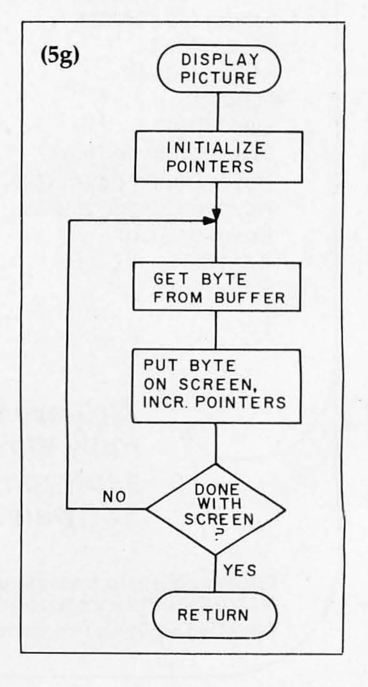
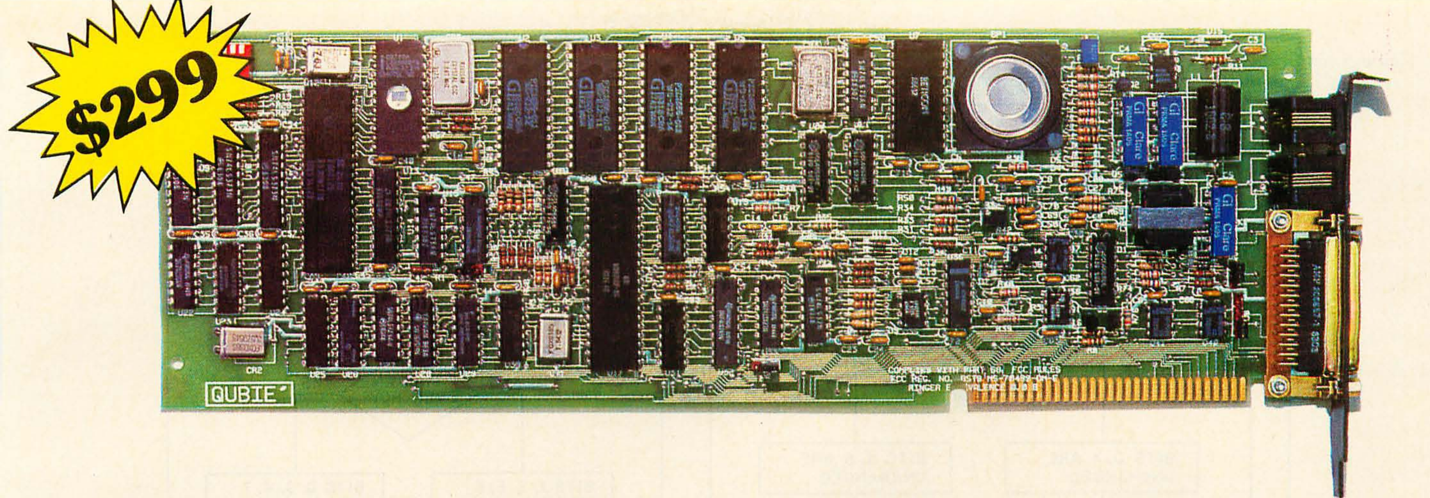


Figure continued on page 82



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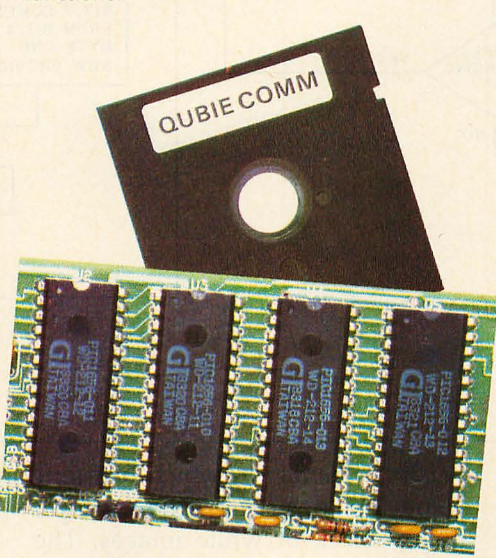
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Figure 5 continued:

(5h)

ENHANCE

INITIALIZE POINTERS

IS THIS AN EVEN ROW ?

NO

YES

BITS 0, 4 ARE UNCHANGED

BIT 2 GOES TO BIT 5 OF BYTE ONE ROW AWAY

BIT 6 GOES TO BIT 1 OF BYTE + 1 ONE ROW AWAY INCR. POINTERS

BITS 2, 6 ARE UNCHANGED

BIT 0 GOES TO BIT 3 OF BYTE ONE ROW AWAY

BIT 4 GOES TO BIT 7 OF BYTE ONE ROW AWAY INCR. POINTERS

DONE ENHANCING ?

YES

NO

INITIALIZE FILLIN POINTERS

IS THIS AN EVEN ROW ?

NO

YES

BITS 1, 2, 5, 6 ARE "HOLES"

BITS 0, 4 ARE UNCHANGED

BIT 3 COMES FROM BIT 0 OF BYTE ONE ROW PREVIOUS

BIT 7 COMES FROM BIT 4 OF BYTE ONE ROW PREVIOUS

BITS 0, 3, 4, 7 ARE "HOLES"

BITS 2, 6 ARE UNCHANGED

BIT 5 COMES FROM BIT 2 OF BYTE ONE ROW PREVIOUS

BIT 1 COMES FROM BIT 6 OF BYTE - 1 ONE ROW PREVIOUS

INCREMENT POINTERS

DONE WITH FILLIN ?

NO

YES

RETURN

Text continued from page 76:
will be completely white. These situations may be remedied by increasing or decreasing the exposure time or changing the lens aperture. You may need to focus, also. Eventually, a clear picture will appear on the video screen when the lens is properly adjusted.

The gray-scale portion of the program demonstrates what can be done with just a little bit of software enhancement, permitting you to create images with 14 intermediate levels of brightness (plus extreme dark and bright) and display them on the Apple's hi-res screen. The image of an automobile shown in photo 1 is an example.

The technique used to display the gray-scale pictures on the Apple II Plus and IIe computers is known as *ordered dithering,* in which half-tone values are constructed from multiple binary black or white images. The process requires the Micro D-Cam system to take 15 exposures of the same subject, each lasting a little longer than the previous one. (This normally takes only several seconds.) After each exposure is taken, every pixel in it is checked. If the pixel is on (showing a 1 value corresponding to brightness above that exposure's threshold), a counter location corresponding to that pixel is incremented. At the end of 15 passes, this process yields a table of values, each value describing the relative intensity of its corresponding pixel. For example, if a pixel's final value is 15, that pixel should be displayed maximally bright; if a pixel's value is 8, the pixel deserves a shade of gray halfway between the black and white extremes.

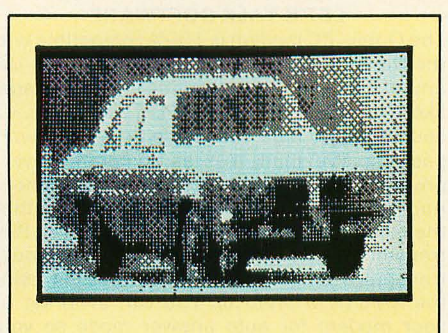
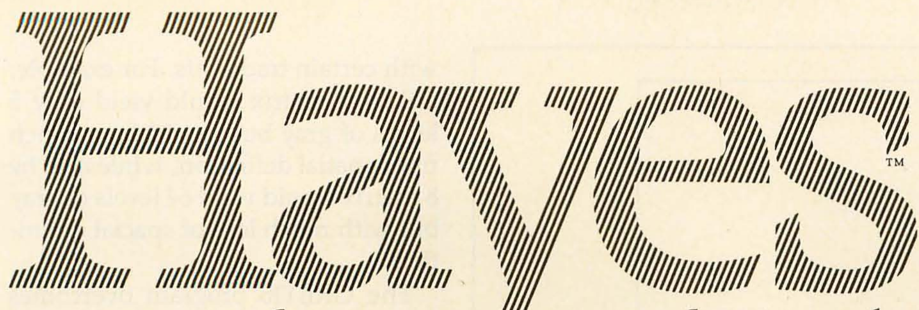


Photo 1: *The Micro D-Cam was aimed at a car parked outside. The dithered digital gray-scale image shown here is displayed by an Apple II Plus.*

Once the pixel-intensity table has been constructed, a 4 by 4 dither



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(2a)

(2b)



Photo 2: *A corner of the author's business card (2a) was easily reproduced by the Micro D-Cam (2b) because the printing represents only two levels of brightness. One potential use of the image camera is in optical character recognition.*

matrix is used to assign a display value (an array of binary pixels) to each screen position. In this software, the matrix is as follows:

0	8	2	10
12	4	14	6
3	11	1	9
15	7	13	5

Then, one pixel at a time, the values in the table of final image magnitudes are compared to the array-element values in the matrix. If the image value for the pixel is greater than the element's value, that array element is turned on. If the intensity value is 0, none of the matrix elements are displayed bright; if the value is 8, elements 0 through 8 are displayed bright; and if the value is 15, all the elements become bright. In this manner, 15 levels of luminance may be represented but at a certain loss of spatial definition. The process is repeated across the entire screen until each screen position has a value assigned to it.

It would definitely be possible to use different-size dithering matrices, with certain trade-offs. For example, a 2 by 2 matrix would yield only 5 levels of gray but would have much finer spatial definition, while an 8 by 8 matrix would yield 64 levels of gray but with much loss of spacial definition.

The GREY16 program overcomes many of the limitations associated with binary optical sensors. While black print on white paper (like my business card, shown in photo 2) is easily viewed by the Micro D-Cam with no enhancement, we don't live in a pure-black-and-white world, and three-dimensional objects need shading to be recognized on a two-dimensional video display.

This is most easily demonstrated with a series of photos of a pair of dice. Photo 3a shows the color and lighting conditions of our sample object. If we use the Micro D-Cam without gray scale, we obtain the binary picture in photo 3b. (This slightly vague yet quite representative picture of the dice would probably be usable in robotics or some recognition applications.)

For a more representative picture, we can invoke the G command in the GREY16 program to produce photo 3c. There is now no question of what the subject is or what value is shown on the dice. If the image were reproduced on a computer capable of displaying half-tones, it would look much more like photo 3a than this dithered Apple II Plus display.

(3a)



(3b)



(3c)

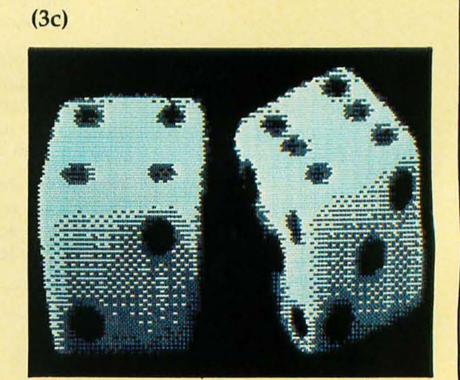


Photo 3: *A pair of dice (3a) was scanned by the Micro D-Cam. When only two levels of luminance are recorded and sent to the computer's display, the result is the output shown in photo 3b. When multiple gray-scale exposures and ordered dithering are invoked, the more easily recognizable output of photo 3c appears.*

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Closing Observations

Two articles have not been enough to describe all the capabilities of the Micro D-Cam. If I had more time, I'd try some experiments using different lenses and filters. Theoretically, if three exposures were taken through red, green, and blue filters, we should be able to create a color image.

One interesting fact I did observe is that the IS32, like most silicon-based image sensors, is infrared-sensitive. My test was somewhat unscientific, and I have no precise data on the Optic RAM's spectral sensitivity. I merely lighted the subject with some infrared light-emitting diodes, but it was clearly seen by the Micro D-Cam even in visible-light darkness.

This mild success leads me to consider related experiments. Don't count on it, but in a few months you just might be reading about some sort of character-recognition wand I've built using an Optic RAM. In the meantime, if you find any other dynamic RAM chips that are suitable in this application or wish to show me a character-recognition program of your own, please write and let me know.

Next Month:

Communicating with their fellow humans can be a problem for people who cannot speak. We'll look at a way digital electronics can be harnessed to remedy this difficulty. ■

Editor's Note: *For a review of a similar assembled product,* *see page 316.*

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Ciarcia's Circuit Cellar, Volume I *covers articles that appeared in BYTE from September 1977 through November 1978.* Ciarcia's Circuit Cellar, Volume II *contains articles from December 1978 through June 1980.* Ciarcia's Circuit Cellar, Volume III *contains articles from July 1980 through December 1981.*

Special thanks to Carl Baker and Jim Herrud of Micron Technology Inc. for their contributions to this project.

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Steve Ciarcia (POB 582, Glastonbury, CT 06033) is an electronics engineer and computer consultant with experience in process control, digital design, nuclear instrumentation, product development, and marketing. In addition to writing for BYTE, he has published several books.

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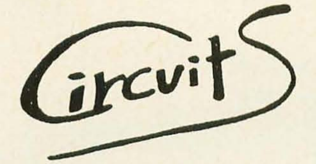
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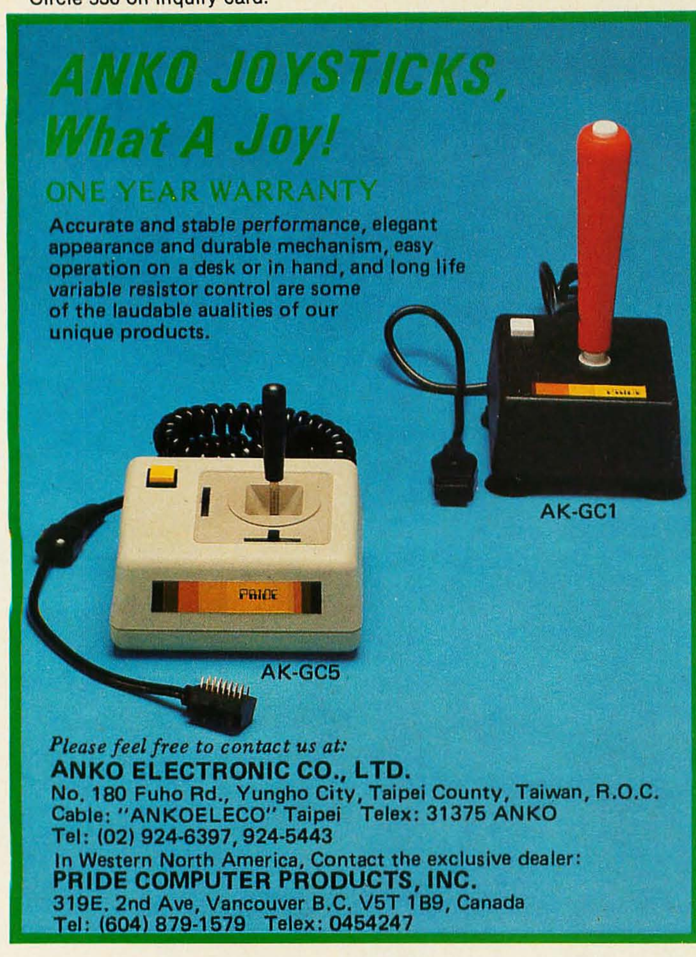
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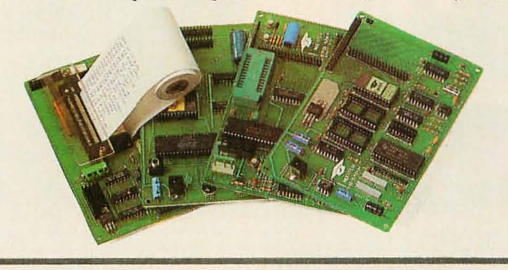
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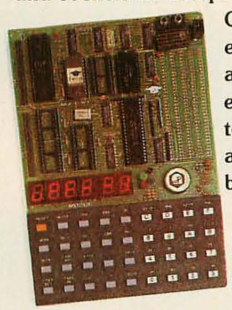
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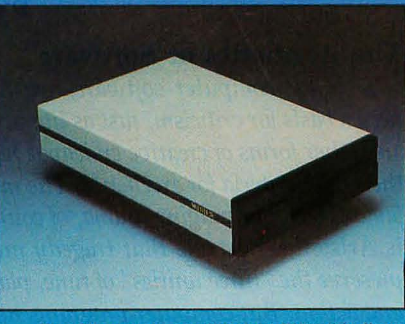






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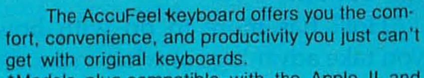
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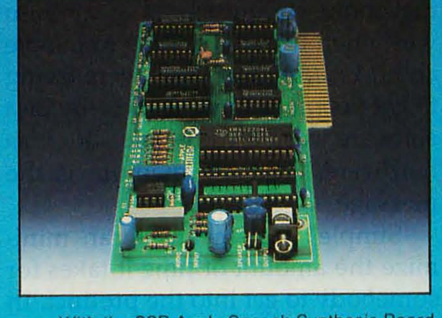
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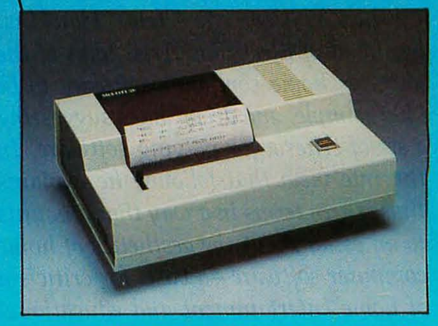
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Shaping Consumer Software

Trip Hawkins of Electronic Arts explains his criteria for judging software and presents his view of the programmer as artist

by Phil Lemmons and Barbara Robertson

The Aesthetics of Software

To judge computer software, we first need a basis for criticism, just as literature and other forms of creative endeavor have their own criteria for excellence. The most famous basis for judging drama, of course, is Aristotle's doctrine that tragedy must preserve the "three unities" of time, place, and action. But computer programs have an important characteristic that literature lacks: multiple branching. Computer programs have hundreds and thousands of conditional steps, and a user can run a program many times without ever taking the same path twice. Furthermore, the computer has special characteristics as a medium.

When William M. "Trip" Hawkins, president of Electronic Arts, talks of the need for home computer software to be "hot, simple, and deep," he is suggesting a set of criteria for judging software. In the interview that follows, he explains those three terms in a way that amounts to an essay about the aesthetics of home computer software—a basis for criticism of home entertainment and educational programs. Hawkins's views should prompt discussions among computer users about the nature of software, and in time those discussions may form the basis of an aesthetic to stand alongside those of literature and art.

BYTE West Coast Bureau Chief Phil Lemmons and West Coast Technical Editor Barbara Robertson interviewed Hawkins at Electronic Arts' office in San Mateo, California. BYTE's questions to Hawkins appear in boldface, and Hawkins's responses follow in lightface.

What Software Should Be Like

You have said that software must be "hot, simple, and deep." Did you borrow those terms from some latter-day Marshall McLuhan?

No, I made them up. "Simple" came from Lisa. The first time I started talking about computers as a medium was when I started talking to people about Lisa. At Apple we were trying to get people to understand why Lisa software was only possible with Lisa hardware. And the medium is the message.

"Simple" just means I can minimize the amount of time it takes for somebody to get into the product. In that sense, "simple" can apply to any kind of application, whether it's a game, an educational product, something to satisfy the intellectual curiosity of an adult, or something that pays your bills for you.

When I worked at Apple, we had a struggle with Lisa in the early going. The engineers wanted to know whether or not the person who would be operating the Lisa would be a naive or sophisticated user. We finally convinced them it really didn't matter whether it was a CEO or a secretary—everybody considers his or her own time precious and wouldn't want to spend any time learning to use the computer and software.

And in the consumer market, leisure time is precious, too, whether it's Johnny's leisure time after school or a parent's on the weekend. Nobody wants to spend time studying a manual to play a game. The idea of having to read a manual to play a game is pretty scary in itself.

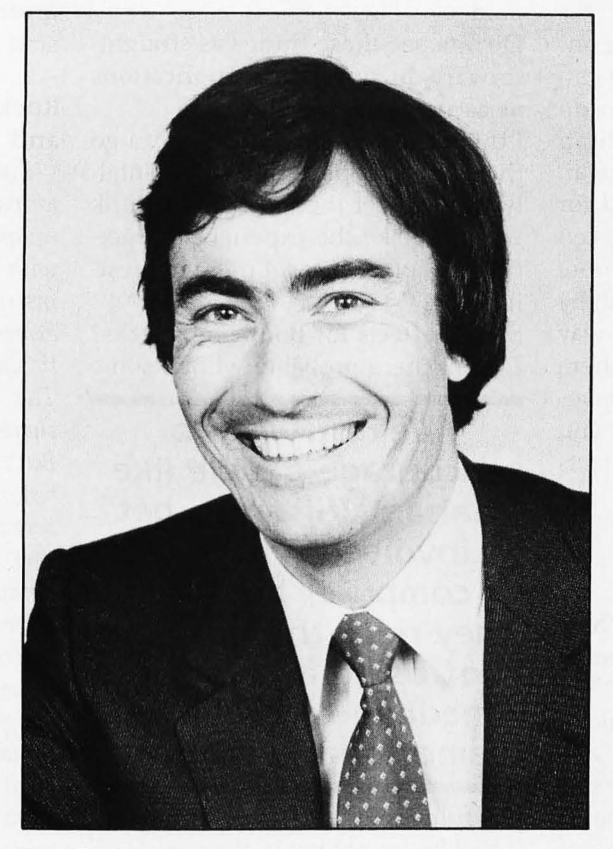
The "simple" part has to do with how the program is presented on the screen and what kind of controls you use to interact with it. For example, Mule is an economic simulation game, and there's a whole lot going on. There are a lot of financial transactions, but you never do anything except move your joystick and push the button.

"Hot" has more to do with how you take advantage of what a specific computer can do. For example, the Atari offers much better sound than the Apple, so it's important for an Atari machine and an Atari owner to get a product that takes advantage of that. "Hot" means how well this product uses the heat that's in this medium, how well it takes advantage of the special things it can do.

You're always trying to take advantage of the maximum rate at which somebody can absorb information. And getting the medium as hot as

possible makes it easy to do that.

The computer really has four things going for it as a medium. Two are sound and video—you have to use sound and the screen to the fullest advantage. The third asset of computers is their interactiveness—the natural feedback loop. People get a lot just from the machine making a funny noise because of some action they've taken. The fourth asset is what I call "hidden machinery," the fact that the computer, because it's a data-processing machine, can take an enormous amount of information and keep track of it, providing a structure for it that is completely invisible to the consumer.


Trip Hawkins

The best example I can think of is Flight Simulator. All you can see on the screen is the view out the cockpit and the controls spinning around, but there's all this scaffolding behind it that will sustain you in the air, and you don't have to deal with any of that.

Flight Simulator creates a realistic experience. Realism usually is based on data, and the more data you have for a situation, the more realistic it is. But if that data is apparent to you as you use the program, then the complexity is going to be apparent to you. And that's the problem. Imagine what Flight Simulator would be like if I played it as a board game. It would be a disaster. I'd be constantly computing my velocity, my altitude, and all kinds of other things.

The same thing goes for adventure games. Think of an experience like Dungeons and Dragons, where you're trying to create a very realistic adventure. There are all these charts and tables and complicated manuals, and you're trying to figure out how much weight each person's carrying and where he's holding different weapons, how much each one is paid for the weapons, what kind of damage the weapons do when they hit, what percentage of the time they hit, and what kind of monster they're attacking. You have to keep track of all this data. Computers are really good at keeping track of that, and they should be used to hide the machinery.

Getting a program to be hot is a combination of taking advantage of all four of a computer's assets. I think you're failing to fulfill the promise of home computing if you're not pushing those as far as you can with a particular idea. Video games tend to be purely visually oriented; sound effects haven't been that far advanced. With a really good video game you've got some interesting interaction, some interesting graphics, and some interesting sound, but you're not taking advantage of the hidden machinery.

That's partly why "deep" comes in. A lot of video games are simple and hot, but almost none of them are deep. A lot of that has to do with the fact that an arcade is a crazy place with lots of noise and distraction. You can't take time to think about what you're doing; you've just got to be reacting. And the experience has to be over and done with in 60 seconds. In the home you don't have that constraint, so you can do things differently and offer greater variety.

I don't think anybody's going to have sustained interest in something that's not involving them at all mentally. A mindless reaction is OK for a few minutes' relaxation, but it's certainly not going to become a large portion of your leisure time over years.

Parents don't particularly want to encourage that, anyway. What they really want is products that have *depth*. Again, if I can use Mule as an example, it's a very complicated economic simulation. But when you start playing, there's a beginner version, so some of the complexity is very deliberately stripped out of it, and you only have to learn how to move the joystick and press the button. There are some very interesting music and graphics, and it's still more complicated than a typical video game. In other words, you have to learn how to do a few things and understand a few mechanisms on the screen. Once you get those down, you know how to play.

But learning how to become a good player of the tournament game is totally different—by the time you're playing for the fiftieth time, you're still learning things about it. And a lot of the basic rules of economics are cleverly concealed, so you learn things like the learning curve theory of production, economies of scale, basic supply and demand and bargaining, acquired resources and scarcity or controlling price through

market share, and collusion. It's phenomenal how much is going on.

Even so, when you start out it can be very simple; in fact, you can do other things in the game to handicap people. If, for example, you have an adult playing with a 10-year-old for the first time, the child can be given a special character that has more points and has a longer turn, and the adult can be handicapped. The way you handicap adults is to make them humanoids, and since the game takes place on a foreign planet, you assume that its harsh climate affects the humans.

Simple, Hot, and Deep in Other Software

Do ideas like "simple" and "hot" apply to both educational and entertainment software?

Yes. Anyone who tries to make a distinction between education and entertainment doesn't know the first thing about either. I see the meat of this market in products that combine entertainment and education and don't consciously try to separate the two. A part of our market is still pure fun, and another part is pure learning, but I think the meat of the market is those two in combination.

We see two other parts of the market as distinct. We call one "personal development" just because that's a better way of describing the way an adult thinks about education. In more cases than not, you're indulging a particular intellectual curiosity about how computers work, about music, art, chemistry, or anything you feel like learning about or tinkering around with. A computer is a very interactive playmate for doing that.

The fourth market after entertainment, education, and personal development is home management. That divides into information management and financial management. Information management includes word processing, retrieving information from other computers, and so on. And then there's financial management, which includes things like how to make financial planning decisions and how to figure out how to finance a new house or get your taxes paid.

Do you see those things as straightforward business-like applications or as games as well?

I think there's a direction we can go there, but people still fundamentally want to get the job done. I think we can make the experience of getting the job done a lot more interesting.

Sound effects for bouncing checks?

I think there probably will be some playfulness for that sort of thing, but it had better not get in the way of efficiency. Simple applies equally well across all those categories. Hot also applies equally well because you're trying to figure out how to take what a specific computer can do and make it as compelling as possible. Deep really has more to do with whether or not I find the bottom of the product quickly. Clearly, I don't *want* to find the bottom of it quickly; I want it to continue to be interesting, continue to unfold.

We're trying to encourage people like Gahan Wilson to get involved with the computer because they're in the business of using an artistic medium to evoke an emotional response.

We understand some of your programs are going to involve interesting collaborations.

We're trying to get people like Gahan Wilson involved with the computer because they're in the business of using an artistic medium to evoke an emotional response. Most people in computers haven't thought about the medium that way. We're really trying to encourage that. I think it's going to take a style of software development that's more accessible, where programming is no longer exclusively the province of the people who know how to handcraft assembly code. People who know how to handcraft assembly code seldom are as aesthetically oriented as Bill Budge or as oriented toward emotion as a great film director. You're going to start to see more collaborative efforts.

Rock, Flicks, and Object Code

Every artist shapes a creation or performance around the capabilities of the equipment used. The musician must work with vocal cords or the harmonics of an instrument. The actor calls upon facial expression, body movements, and the particular characteristics of the film camera. The software programmer, too, must shape a program to existing technology. But the personal computer goes one step beyond by allowing interactiveness. *A performance becomes an integration of the user, the programmer's software, and the hardware. Yet the programmer, unlike the performer, takes a back seat to the instrument—the computer—when it comes to recognition. With the exception of a few famed instruments such as the Stradivarius violin, praise for the equipment over the performer does not occur anywhere but in the software programming industry.*

Still, the entertainment industry provides parallels for the software industry. Both combine the skills of many people to produce a product—be it an album, a motion picture, or a program. Financial arrangements, however, vary considerably.

In the popular music industry, the songwriter, the musician, and the producer generally get royalties. The musician divides royalties with an agent, a business manager, a personal manager, and perhaps a public relations firm. In the motion picture industry, the company is the producer. Screenwriters get fees or perhaps a small percentage of the film's earnings. The actor gets fees, a percentage, or both, and usually pays some part of the earnings to an agent, a business manager, a publicity agent, and so on.

The software industry is different. The programmer may be an employee who writes code to implement someone else's idea, or he may generate the original idea, the detailed design, and the code itself. In the latter case, the programmer can sell the program for a flat fee, give it to a publisher in exchange for a royalty, or produce copies and contract with a distributor to sell to retail stores or directly to users.

Trip Hawkins and Electronic Arts are

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leaders in the movement to treat programmers as artists and reward them accordingly. As Hawkins notes, however, the analogy of the software business to show business can easily be strained.

When did you get the idea to organize this software house on a different model?

At Apple, while we were working on Lisa. Lisa software was inhibited by the need to have so many people simultaneously in agreement. That would be difficult regardless of the collection of people involved.

It occurred to me that in film, television, books, and other forms of entertainment media, artists all work kind of independently. And already by that time there were certainly examples of that in programming. Bill Budge, for example, had done some space games and then he worked for Apple for six months.

I think a lot of software people have plunged into building a huge software organization without realizing the limits to growth that eventually you're going to have to live with.

What are those?

The "mythical man-month," for one. Nine women can't make a baby in a month. And there comes a point in a software project where if you add more people it'll never get done. And I think that you have to find ways to keep things decentralized. Our model of the world is sort of the ultimate in decentralization.

The question is, how can we make these talented programmers and program designers who are working scattered all over the world as productive as possible? Once we can answer that, making the company grow indefinitely is just a function of finding the best talent and leveraging it more effectively than someone else can.

We have all the advantages that go with a small company. We can have a more personal relationship with the programmers. Apple certainly wasn't a huge company, but it had a lot of trouble, as many corporations do, dealing with the idea of putting the software people on a pedestal and treating them differently from everyone else. I realized, hey, they *are* different—let's put them up on a pedestal.

Based on your view of home computers as a new medium and of programmers as artists, how have you organized Electronic Arts differently from other software houses?

The most important department is the talent department, and that's staffed with producers. Producers basically manage the relationship with the artist. They find the talent, work out product deals, get contracts signed, manage them, and bring them to their conclusion. The producers do most of the things that a product manager does. They don't do the marketing, which in some cases product managers do. They don't make decisions about packaging and merchandising, but they do get involved.

Our producers are very important people—they're a little like book editors, a little like film producers, and a lot like product managers.

They're like book editors, then?

Yes, they're a little like book editors, a little bit like film producers, and a lot like product managers. I think the biggest time sink for a producer over the full course of the product development is working with the software artist while he's finishing the software—turning around new releases and getting the bugs eliminated and getting manuals straightened out. Usually what happens on the manual is that the original artist will provide something in some rough form, and the producer will figure out how to turn that into a final manual.

Do producers get salaries?

Yes, they're on salary. Some day, when it becomes really easy to figure out a measure of a producer's effectiveness, these people will get a piece of the action. Their performance will be based on how well the products do. I'm already trying to get them to think like portfolio managers—you have this much cash to invest in terms of advances, and you've got this kind of bottom line to play with in terms of what royalty percentage you can give out, so how much can you spend on the overall marketing, that sort of thing. The idea is to figure out how to produce the most revenue from that. And whether you want a couple of really expensive high-risk, high-reward possibilities, or some of those balanced with some inexpensive 18-year-olds and one more expensive educational group or whatever.

What are the producers' backgrounds?

We have five of them full-time right now. Three of them worked at Apple; in fact, two of them worked directly for me. One was product marketing manager for all the Lisa software, and she's very good at working with engineering people. The other two people from Apple had similar kinds of reputations for being good at working with engineering people. One producer sold computers for IBM and then became an executive recruiter. He signed Gahan Wilson. Our fifth producer, who came from one of our competitors, Automated Simulations, was basically doing all of the company's product marketing. She's basically a social scientist.

Are most of your contracts with individuals or with groups?

It's a range. You have guys like Bill Budge who are individuals and then you have guys from a company like Childware, where it's a group of about four. Then there's another category where there might be one key individual, somebody like Dan Bunten at Ozark Softscape or Jon Freeman at Free Fall Associates. Dan Bunten's the guy who did Cartels and Cutthroats, Cytron Master, and Computer Quarterback. He did those pretty much on his own, but now he has his brother and some other family members involved, and they set up a separate company.

Then you have people like Jon Freeman. He specializes in design—game design, not even program design. His wife, Anne Westfall, specializes in program design. And then there are two other guys that they work with; one is strictly a program-

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mer, and the other is a combination programmer and game designer, so it's a little bit of everything. Actually, I guess right now the solo performers are the exception. We have only four or five who can really work that independently.

Do you, like book publishers, get unsolicited products, unsolicited disks?

We do. We expect that their volume is going to go up a lot once we're on the market.

Do you welcome that?

Absolutely, although you tend to have a very low hit rate—about one in a hundred or worse. I've already been through that at Apple, and Rich Melmon, our vice-president for marketing, went through it at Visicorp.

When a programmer signs a contract with you, how is it likely to make his life different than if he were doing software on his own?

It's a really big difference. The guy to talk to about that would be Bill Budge because he recently was running his own company. I know in Bill's case, there's a lot of time you spend answering the phone, talking to distributors, getting orders, approving artwork or packaging, getting labels printed, doing mailings to dealers, just doing a whole lot of stuff that I find interesting. People like Bill find it thoroughly tedious. Some programmers out there enjoy it, and I think in some cases it will prove to be their downfall because they're not very good at it, but they like it, and so they'll do a mediocre job both running a company and trying to do the software.

In some situations now we're much happier to be dealing with lawyers rather than programmers because they don't get freaked-out when they first see a contract.

Do you expect to be dealing with agents for programmers some day?

Sometimes we already do. They do exist. In some cases they're just lawyers, but, depending on the amount of experience they have, they can be very smart. There are situations right now where we're much happier to be dealing with lawyers because they don't get freaked-out when they first see a contract.

Contracts with Programmers

What are contracts with programmers like now?

The typical software contract spends most of the time talking about maintenance and support and stuff like that. Once the kind of software that we buy from an outsider is done, it's done, so there's less emphasis on issues like support. There's more emphasis, though, on the rights to different kinds of things. So in fact it's really much more closely modeled after a recording contract. We want to make sure that if we ever want to do "greatest hits of 1983," we can put all the programs on one disk.

What about the fundamental financial aspects of the contract?

It really boils down to a royalty rate on products that we manufacture, which is the market range, typically 10 to 20 percent of the wholesale revenue. Some manufacturers are more out of sync with the market than others, but I think over the next year the rates will become reasonably standard, the same way they are in the record business. Right now they're still all over the map.

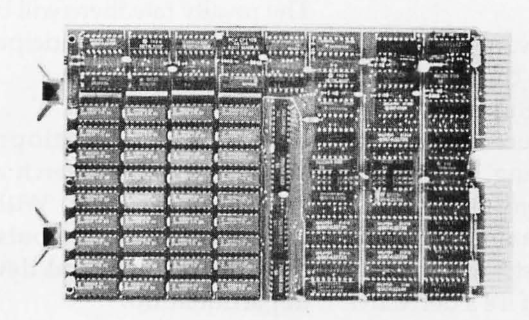
How does the range in software compare with what's available in books?

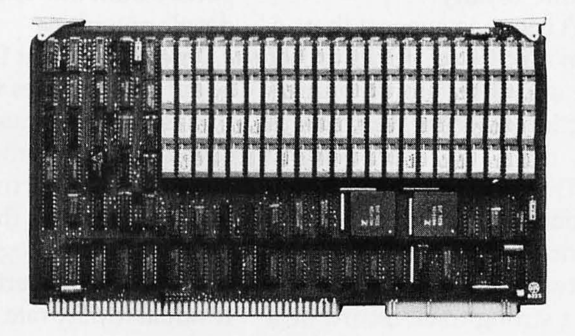
We don't actually encourage too much of a range. So much of our business is driven by percentages of sales that you can't really justify paying a much higher percentage of sales to one guy than another guy. What you're really looking for is higher total revenue on a better product. If you look at our marketing costs, sales commissions, things like rack servicing fees and administrative and R&D budgets, they all tend to be set up as a percentage of sales. What you're really looking for in a big hit product is something that is going to do so much more sales volume that all of

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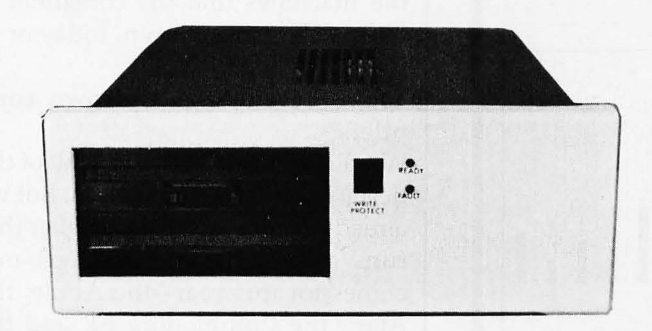
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those percentages start to work in your favor.

So all your programmers will be getting the same royalty?

No, I wasn't trying to suggest that. A certain amount is a function of bargaining and a certain amount is just a function of what we think is fair. The rates are not widely disparate. The thing that does change is the amount of the advance, and that's a function of the track record of the software artist. If he or she really has a strong track record or if the software development method used is clearly more expensive than somebody else's, but we think it's the right method, then we're going to pay for it.

For example, right now we're working with Childware, a group that specializes in educational software. When people from the company came in and showed us their first script, it was something like 32 professionally drawn pictures on a storyboard. That kind of richness of communication is going to cost you. Some of these groups now have a staff graphic artist and a staff musician, and they'll have certain expenses built into the way they do the development.

One other point I wanted to make about the royalties is that we divide things into three categories. There are royalty rates on products that we are actually manufacturing. There are two subcategories there. One is products where the programming is done by the original artist, who gets a residual royalty rate. If it's a derivative version that's on a machine in which the artist did not do the original programming, he still gets some royalty, and that's worked out.

The second category is licenses. For example, the Bolivian government says, "We'll pay you $100,000 just for the rights to convert Pinball Construction Set to Bolivian." If there's a straight license, a much higher percentage of that goes to the artist because we don't have to do any manufacturing and distribution.

The third category really has more to do with merchandising. We may want to create a product specifically for merchandising, but we're not the manufacturer. For example, a T-shirt. The royalty rate there will be very low because we're not anticipating making any money on it.

Research and Development

You also have a research and development department. With the software written mostly outside, what does the research and development department do?

Develop proprietary software tools that our software artists can use to build products faster and to build products that they couldn't build on their own.

Utilities that construct graphics for a particular machine?

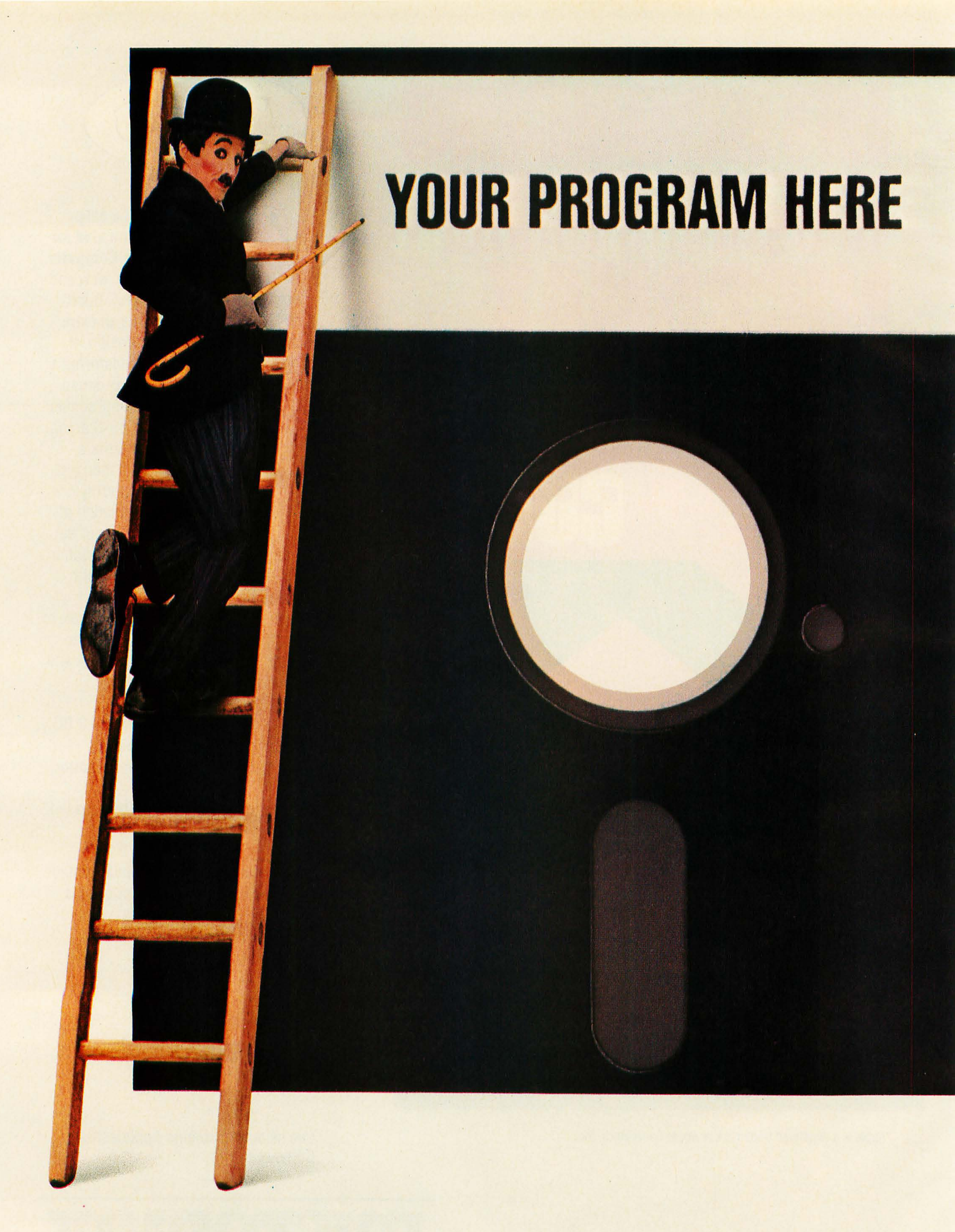
Let me talk short term and then long term. In the short term there are things like software theft protection, assistance in getting up on a machine that the particular artist is not familiar with, and assistance with sound. It's more the nuts and bolts kind of thing right now.

In the long term, we're going to put together a workstation that is specifically designed for creating the kind of software that we want to create. And the development system will have things like languages and debugging tools and compilers, and it'll have a lot more memory and a lot more processing power than any of the machines that the consumer is ultimately going to own, today or in the future.

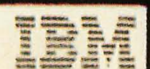
You're developing your own compilers?

We're not necessarily doing all of the development work ourselves. But we already have a FORTH compiler that runs on all four of our target machines for this year—the Apple, the Atari, the Commodore 64, and the IBM PC. We're bringing it up on our first version of the development system. We might have toolkits for sound and graphics, and so on.■

Phil Lemmons is BYTE's West Coast Bureau Chief. Barbara Robertson is West Coast Technical Editor. They can be reached at McGraw-Hill, 425 Battery St., San Francisco, CA 94111.



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New Computers, Boards, Languages, and Other Tidbits

What may be a revolutionary medical program highlights this month's potpourri

by Jerry Pournelle

I'm writing a lot of this on my Otrona in a San Jose hotel room. I don't quite know where the month of June went. Actually, I do: two speeches, a convention, and a lot of work on my novel. Make that three speeches.

Fortunately, there's a lot to write about. Of course, when you're writing about the micro business, there's *always* a lot to write about.

For example: Modula-2/86 is here. The version I have just now runs on the IBM PC under CP/M-86; by the time you read this, there should be others. The Logitech version includes source code (in Modula-2, of course) for KEYBOARD.MOD and DISPLAY.MOD, which are the modules that define the keyboards and display; by fooling about with them, you can make Modula-2 work with a number of PC work-alikes.

You can be sure I'll have more to say about Modula-2.

Something Really Wonderful

I like to give speeches. Most writers do, and as a former professor I often miss my classroom. I simply don't have the time to do it as often as I would like.

I particularly like to give speeches at conferences because I get to meet the other speakers and I learn things it might take me years to discover otherwise. That happened not long ago at a physicians' conference in Vail, Colorado: I saw a real vision of the future of the micro.

I was supposed to speak at 0900, an hour I don't much care for. Physicians apparently are much earlier risers than I, for they were supposed to have a speaker at 0830. She was sensible, though, and presumed it a misprint, so they didn't have anyone at that ghastly hour. Rather than waste their time, they invited the next day's speaker to begin. He turned out to be Dr. Lawrence Weed, and he hadn't finished when I arrived. I thus discovered by accident the most exciting computer program I've seen this year.

The official name is Problem-Knowledge Coupler. I'd be more likely to call it "Diagnosis by Computer" or an "Auto-Doc." The interesting thing is that the night before I was discussing the possibility that "someday" there would be computer programs to assist in diagnosis, and several physicians and I agreed that day would not come soon.

We were wrong. The Problem-Knowledge Coupler (PKC) is here right now. Dr. Weed demonstrated it to a fascinated group of physicians. Although most were pleased to see it, one medical student was terrified. "What is there for us to do if the machines can do it all?" he asked.

Of course, the PKC doesn't "do it all," but it sure does a lot.

It is common knowledge that a patient's medical record is the single most important diagnostic tool available to a physician. A case history plus a good description of symptoms are vital to meaningful understanding. The PKC makes use of this.

A PKC is, of course, *a computer* program. The patient enters as much of his case history and symptoms as possible in response to a series of questions asked by the program. I'm told this can be done as a dialogue between patient and machine, but I'm sure it's a lot smoother if mediated by a medical professional, such as an office nurse.

Other information, such as blood pressure, pulse, and the like, can be entered by the nurse or the physician. When it's all done, the program offers a list of possible causes.

Note that the machine hasn't "made a diagnosis." It doesn't even present a weighted list; it merely gives all it knows about what could have caused the patient's problems. The physician is free to use intuition, leap to conclusions, order further tests, or do anything else that seems indicated.

It's possible that the physician knows of causes that the machine hasn't listed, in which case the program should be updated. According to Larry Weed, however, that's not

the typical situation.

Consider: we're dealing with a lot of symptoms and indicators. Age, weight, sex, presence or absence of facial hair, blood pressure, somatic type, hereditary factors, diet, previous operations—all these can be important. According to Dr. Weed, a physician generally has to think about as many as 40 indicators. Meanwhile, dozens of possible causes may exist, all linked to the various symptoms in highly complex ways.

Medical diagnosis approaches fundamental limits to human capabilities. Weed demonstrated this by giving the audience a list of symptoms and asking for possible diagnoses. The conference, with more than 40 physicians, could come up with no more than a dozen possibilities; the computer program knew of 28.

Clearly, a physician plus Problem-Knowledge Coupler will be more effective than the physician alone, and the more obscure the problem, the more likely this is to be true.

What really astounded me is that the program runs on microcomputers. Dr. Weed has versions for CP/M 2.2 on the North Star Advantage and the IBM PC. It should be easily adaptable to other CP/M systems.

Aye, There's the Rub

Now comes the disclaimer. I am not a physician. My doctorates are in other fields entirely. Clearly, then, I am not competent to evaluate the medical effectiveness of Larry Weed's computer programs.

The programs are certainly easy to use. They seem to run without glitches. I say "seem to" only because I've yet to do any exhaustive testing, although I intend to.

I spent a lot of time with Larry Weed, including taking part in a dialogue discussion with the entire group, and I was much impressed. Weed has solid academic and medical credentials. He's also fond of pointing out that major league baseball teams and professional opera companies do not make use of credentials when hiring talent. Performance organizations want to see what recruits can do, not what they've been taught.

Weed wants his PKC judged on that basis—and of course I can't do it. I haven't the credentials. I can only offer observations.

I've seen the program work with test cases. I've watched it list out probable diagnoses, each accompanied by a reference to a medical text. I've seen it list everything a room full of physicians thought of, then add some they hadn't considered but which when put to them were pronounced both reasonable and possible.

I haven't seen it "verified," nor can I think of a way the program could be verified. In particular, there's obviously no way to be certain that the program will list every possible cause of a particular patient's difficulties. I do think, though, that the program could be of great value to physicians.

My view isn't universal. Some physicians I've spoken with are horrified, and a few have said the programs are "demeaning." I fail to understand why. No one thinks checklists are demeaning; how is it different when the checklist is put on a machine? No one thinks reference libraries are demeaning, and everyone insists that reference books have indexes. The PKC looks to me like a very good index.

In any event, I found the programs fascinating, and I'll have more on the subject in a later column. Meanwhile, I'd appreciate comments from those with medical qualifications.

Kaypro versus Osborne

When I give talks, there's one question I get fairly often: which do I recommend, Kaypro or Osborne? As with most questions, the answer is, "It depends." They're both good machines. When the Kaypro first came out, the Osborne software package was clearly superior to the Kaypro's; that's no longer true. The Kaypro 4 (which is in essence the original Kaypro II with double-sided disks) comes with an excellent selection of software.

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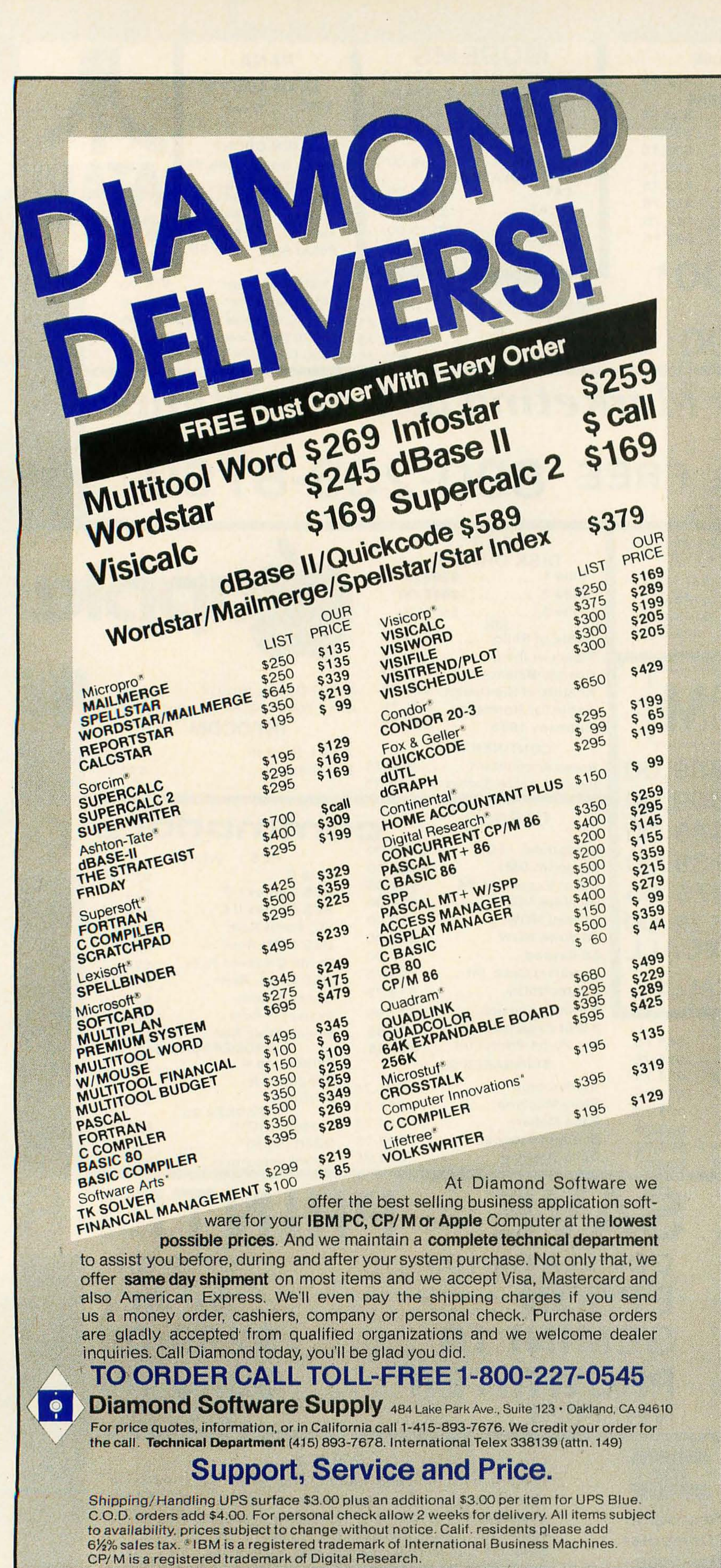
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On the other hand, the Osborne Executive comes with much introductory material and a powerful software package, plus the possibility of updates to compatibility with the IBM PC, an option the Kaypro doesn't have. Osborne also has a widespread network of dealers and service centers; more than Kaypro as of this writing. That, too, is subject to change and could be different by the time you read this.

I have experience with both machines: I had a very early copy of both the Osborne 1 and the Kaypro II. Each had its problems, but all those difficulties were *fixable*. The early Kaypro II had some software problems that caused excessive disk wear. The early Osborne 1 had other troubles, particularly with the keyboards. In both cases the problems have been revised out of the later-production machines. I still have my old Osborne 1, and it does yeoman service as a loan-out machine; Barry Workman ended up buying (from Kaypro Corporation) my old Kaypro II. He has a special program that lets it read a wide selection of disk formats, and it has become a workhorse for his operation. Neither machine has required what I'd call excessive maintenance. They've both had their out-of-service periods, but nothing I wouldn't expect given their hard usage.

Thus, I have no trouble recommending either the Osborne 1 or Kaypro II as a first machine for someone with a low budget. Neither would be my first choice if I could afford more, but both are more than adequate as word processors and general-purpose computers for writers and small-business owners.

By the time you read this, however, you may not be able to find an Osborne 1; they don't make them anymore. They recently dropped the price to $1295, and while they last, that's a pretty good deal. Some do appear on the used market. I've never advised anyone to buy a used computer. Given that this computer no longer exists, there's not a lot of competition down at the low end of the "transportable" professional computer price scale.

Kaypro 4 versus Osborne Executive

Either the Kaypro or the Osborne is satisfactory as a first computer. They're both competitive with anything else in their price range. My experiences with them are a bit limited, but so far neither has given me any trouble, and both are notable improvements over the earlier models—so much so that I urge anyone comtemplating a first machine to try to spring for the extra bucks to get the Executive or Kaypro 4 rather than the Osborne 1 or Kaypro II.

The Executive has true composite video output: you can plug it directly into a monitor (but not a TV). If you want to use the Executive to drive a TV set for demonstrations or simply because you want a larger screen, you'll need an RF modulator. The Kaypro machines do not have any external video output. On the other hand, the screens for both the Executive and the Kaypro machines are adequate, although if I were doing a lot of work with either, I'd want something bigger.

The Executive has a *much* nicer screen, and the character set is more pleasing. These are matters of taste, of course, and not everyone would agree with me.

Neither the Osborne Executive nor the Kaypro can be described as portable. "Transportable," yes; but not portable. Both weigh the same: too much (about 28 pounds stripped). I already have arms like an orangutan from carrying the Otrona Attache. (That machine weighs only 18 pounds, but with disks, power cord, documents, and shoulder-strap carrying case the entire mess comes to about 25 pounds; I'd be smarter to put most of the documents in my checked luggage.) Alex and I have carried both Osborne and Kaypro machines all across the country; you *can* do it, if you have to, although you won't enjoy it.

The Executive has single-sided

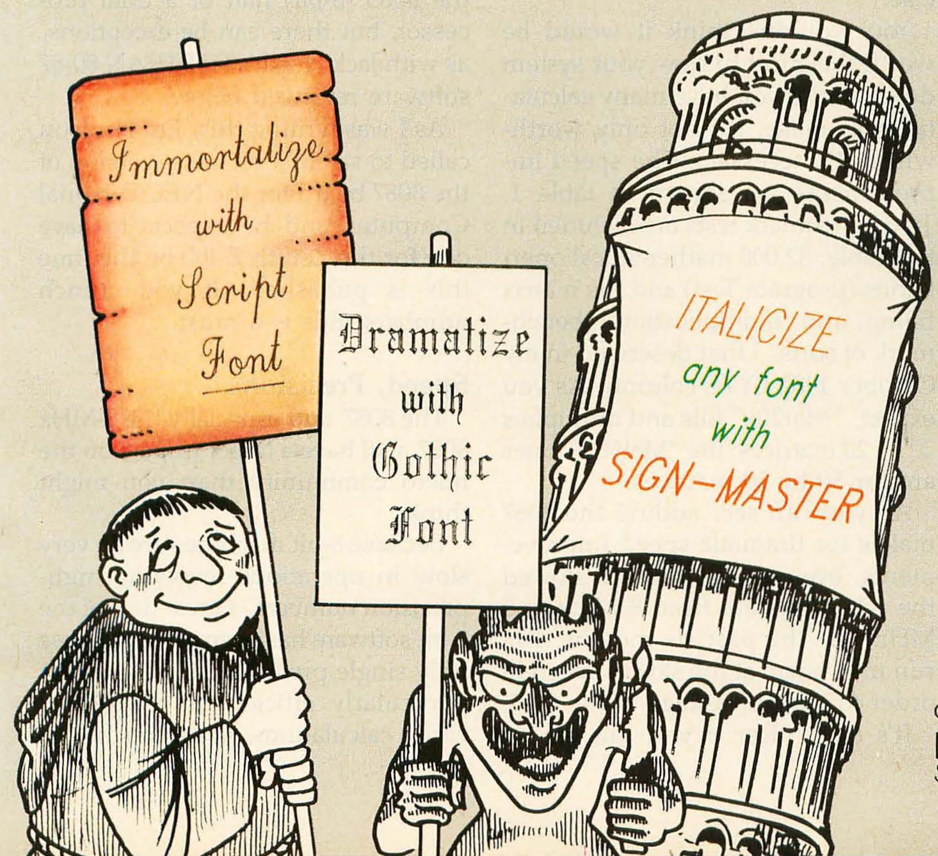
double-density disks (180K bytes per disk); the Kaypro 4 has full double-sided disks, for a full 380K bytes on each. This is probably the most significant hardware difference between the two.

The Executive has two serial output ports and one parallel port that can be either IEEE-488 or Centronics (printer) compatible. Kaypro machines have one serial port and one Centronics port.

The real difference between the machines shows up in packaging and software. The Kaypro was designed by engineers and looks it. Alas, so were most of the Kaypro documents. The latest ones are a *vast* improvement over the ones that came with the first machines, but they still assume you're willing to learn a good bit about CP/M and that you *want* to know things about your computer. Example: whenever your Kaypro does a warm boot, it tells you so by printing the words "warm boot" on the screen. Users not familiar with CP/M react to this in various ways, some of which can be ribald.

The Osborne "philosophy" is that most computer users know little and care less about the way computers work; Adam Osborne would rather commit seppuku with a printed-circuit board than gratuitously tell his users that the machine has done a "warm boot." The Executive runs vanilla CP/M+ (3.0). The Osborne documents assume you don't know what that is and go from there. (When you turn the machine on with a Wordstar disk in it, the Osborne assumes you want to run Wordstar and brings that up; you never see CP/M unless you want to.)

Osborne's software package includes a number of industry standards, such as Supercalc and, of course, Wordstar. There's also Microsoft MBASIC, Digital's CBASIC, and a run-time disk that will let you run programs written in UCSD Pascal (but not write them; you'd have to buy that separately). Also included



Program	8-MHz 8087	5-MHz 8087	8-MHz processor (no 8087)	5-MHz processor
Test n = 32,000	6.55 sec.	9.87 sec.	3 min., 53 sec.	6 min., 12 sec.
Mat20X	4.44 sec.	7.24 sec.	1 min., 11.96 sec.	1 min., 51 sec.
Mat50x	1 min., 3.5 sec.	1 min., 41 sec.	17 min., 52 sec.	27 min., 38.7 sec.

Table 1: *Benchmark tests for the 8087 Systems Support Board.*

is Personal Pearl—six disks' worth. Pearl is a "program writing program"; in practice that means you can write *file*-manager programs with it. If you work at it, you can write some pretty sophisticated stuff.

The Kaypro package is interesting. You have a choice of Perfect Writer or Wordstar; either way you get Wayne Holder's The Word Plus, the best spelling program I know of. The Perfect package includes Perfect Writer, Speller, Filer, and Calc. There's also Chang Lab's Profitplan, a spreadsheet something like Perfectcalc. It's not as good as Supercalc. The package now includes MBASIC and an off-brand BASIC called SBASIC (which is something like CBASIC in both speed and program structure).

In other words, the software packages are comparable. The real difference between Kaypro and Osborne is philosophical. If computers scare you but you can't live without them, Osborne is clearly the better way to go. If you're willing to live with ambiguities and you're curious about small computers, the Kaypro may be more appealing.

They're both good machines.

That's Fast!

Jim Hudson has revised his 8087 math board; it now plugs directly into a Compupro 8085/8088 Dual Processor without modifications to the Compupro board. The board was reworked by Compupro, then redone again by Hudson, who tends to be something of a perfectionist.

The problem with the 8087 "math cruncher" chip is that it runs at 5 MHz (or 5 million cycles per second). That's somewhat slower than the 8 MHz of the 8088 processor ("brain") chip; the result is that if you want the extra math processing speed of the 8087, you have to slow the whole system down. This used to require modifications to the 8085/8088 processor board. Hudson's new board takes care of it without those modifications.

To install Hudson's math board, you must remove the 8088 chip from your processor, plug his board in where your chip used to be, and plug your chip into the empty socket on his board. Two pins on his board interact with the original Compupro processor board to slow it down without your having to do anything else.

You wouldn't think it would be worth the effort to slow your system down, but if you have many calculations to make, it's not only worthwhile, it's necessary. The speed improvements are shown in table 1. Two benchmark tests are included in this table: 32,000 mathematical operations (program Test) and the matrix filling and multiplication "benchmark of sorts" I first described in my October 1982 BYTE column. As you expect, "Mat20x" fills and multiplies 20 by 20 matrices; the "Mat50x" times are for 50 by 50 matrices.

As you can see, adding the 8087 makes for dramatic speed improvements, even though you've slowed the whole system from 8 MHz to 5 MHz. For the past six months, I've run my system at the slower speed in order to take advantage of the 8087.

It's even nicer if you can get an 8-MHz 8087. Intel, which makes the chip, was kind enough to supply one for my system. Hudson's board is designed to let you update by simply snipping off two small pins (it's explained fully in Hudson's documents); that will put your 8088 back up to 8 MHz after you get the faster 8087 chip. Intel's people say they'll be able to supply 8-MHz 8087 chips in quantity toward the end of 1983, possibly by the time you read this.

We put the 8-MHz 8087 in my system and speeded the 8088 back up to 8 MHz. The speed improvement is noticeable. There's also an improvement in disk operation speeds even when running 8-bit software with the 8085. My engineer friends tell me that's impossible. All I can say is that it seems faster.

There's not a *lot* of software that can make use of the 8087, but there's more than I would have supposed. Digital Research supplies 8087 packages with both Pascal MT+/86 and its C86 compilers. In addition, Digital's ASM86 assembler comes with 8087.LIB, a package of 8087 support routines. Supersoft advertises a FORTRAN 86 with 8087 support capability. Logitech's Modula-2 will have 8087 support modules.

Finally, Jim Hudson's piggyback 8087 board normally has no effect on the 8085 (8-bit) half of a dual processor, but there can be exceptions, as with Jack Hersh's FORTRAN 80-87 software reviewed below.

As I was writing this, Jim Hudson called to say that he has a version of the 8087 board for the NEC Personal Computer, and he expects to have one for the Zenith Z-100 by the time this is published. If you crunch numbers, this is a must.

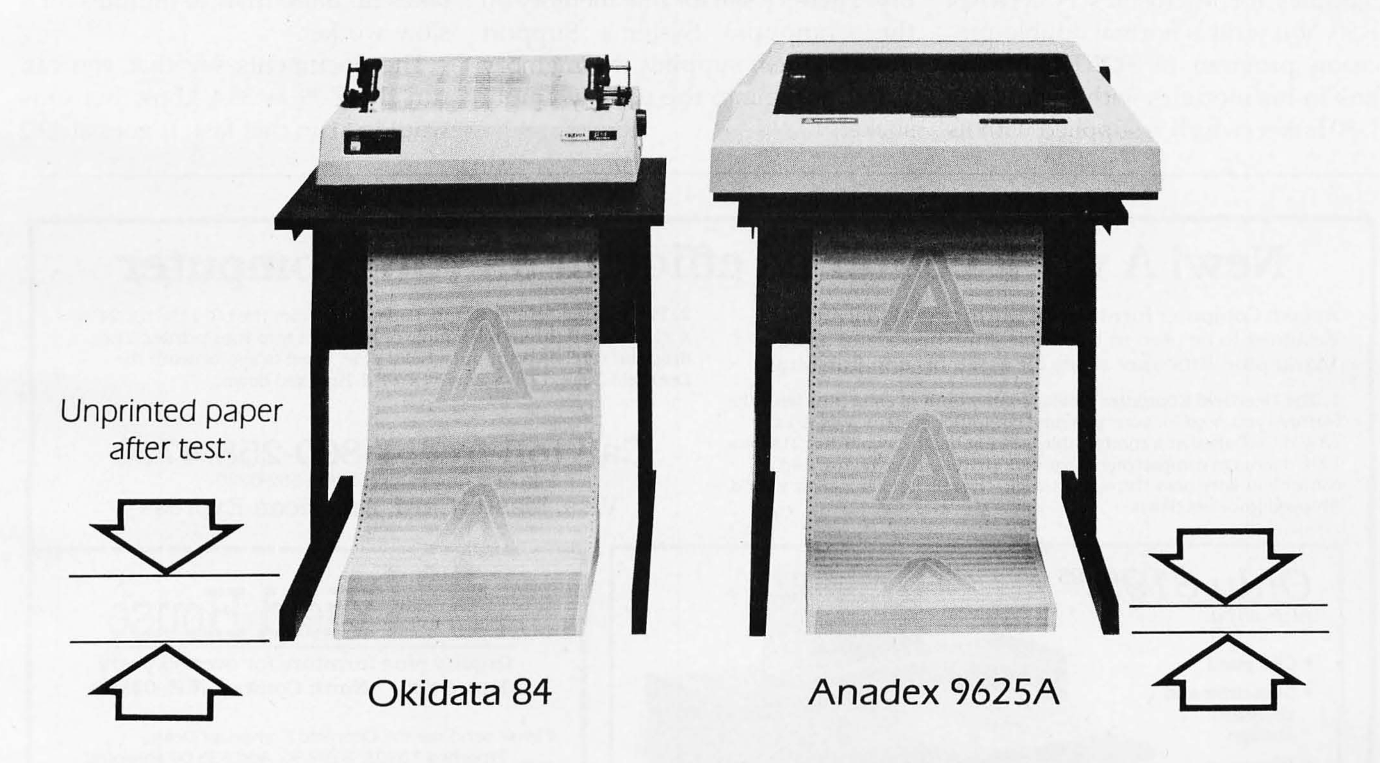
Speed, Precision . . .

The 8087, and especially the 8-MHz 8087, will have a larger impact on the micro community than you might think.

Because 8-bit machines are so very slow in operations involving high-precision numbers, a great deal of the 8-bit software has been written to use only single precision. The 8087 isn't particularly efficient at single-precision calculations, so for much soft-



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ware written for, say, the Z80, there's only a gain of a factor of 3 to 4 if you put an 8087 in the loop.

If you use double precision, there's a gain of perhaps 500.

Thus, older micro programs may not be much improved, but if you want double precision (or greater) from a micro, there's a way to do it, provided you can work in FORTRAN. While I was at Jim Hudson's house, Jack Hersh came in.

People in the micro world tend to have nonmicro origins. Jim Hudson, for example, was an anthropology major in college and ended up working for Intel through a chain of coincidences. Similarly, Jack Hersh started off to be a philosopher but has become a computer whiz. He markets his stuff under the name Avant-Code.

Hersh has written a series of library modules for Microsoft's FORTRAN F-80. You write a normal double-precision program in FORTRAN and link in his modules with Microsoft's L-80 linker (which is supplied with its FORTRAN).

Of course, that won't work on just any system. You need a Compupro Dual Processor with Jim Hudson's 8087 board attached. In addition, you must have the Compupro Systems Support Board, and you must run the system under the Compupro standard CBIOS (customized basic input/output system). Hersh's program runs fine with M-Drive/H pseudo disks, but it won't work with the earlier M-Drive or Warp Drive system.

What's happening, of course, is that although FORTRAN F-80 uses only the 8085 part of a Compupro Dual Processor Board, Hersh's routines wake up the normally dormant 8088 chip and induce it to do the management necessary to coordinate things for the 8087 chip. In order to do that, you need some extra memory. There's a slot for that memory on the Compupro Systems Support Board; Hersh supplies the memory chip to plug into the usually empty socket.

It all sounds complex, but in practice it's easy enough to install and use, and if you have a lot of double-precision numbers to crunch and must use 8-bit software, it's worth looking into.

Jazz Up Your Z-19

The Heath/Zenith Z-19 is a good terminal but has some problems. For one thing, if you try to run it at a really high speed—say at 19,200 bps—it drops characters and otherwise gives me trouble.

Some time ago I was sent a simple fix for that. The Super-19 from Extended Technology Systems does the job nicely. For 50 bucks you get a new ROM (read-only memory) chip and some instructions on how to install it. The whole job, including figuring out how to remove the cover from the Z-19 if you've never done it before, takes no more than 10 minutes for a slow worker.

The documents say that you can run the Z-19 at 38.4 kbps, but ours wouldn't run that fast. It goes at 19.2

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without a glitch, though. The Super-19 got a very extended test when Alex took the Z-19 terminal (with the Super-19 in it) off to UCSD (the school, not the system) last fall, and we both forgot to mention it in previous columns. Alex has had this installed as part of Helen (his CCS Z80 system) for months, with no problems, and he says he'd *never* go back to 9600 bps now. Recommended.

A Glitch or Two

The Z-19 with Super-19 won't run at 38.4 kbps for the same reason that you can have trouble running the Heath/Zenith Z-29 terminal at 19.2 kbps. The cables are very sensitive to electrical noise.

In fact, if you want to run the Z-29 at 19.2, you must use the cables supplied with the machine, and don't extend them. Otherwise, the machine can sometimes drop characters. This can have dramatic results depending on the character dropped; leaving things out of a command string is always inconvenient and often disastrous.

It's a good general principle: if you're trying to run things up toward their limits, pay a lot of attention to cables and cable connectors, and keep all the lines as short as possible. This is only common sense, but it's sense that's too often ignored.

As long as you pay attention to the cables, the Z-29 works fine at 19.2, and we still like it a lot.

Slowly but Surely . . .

A recent letter from Canada complains that the Compupro 8086/8087 board doesn't seem to run much faster than a Z80. My correspondent thought this impossible. I put the problem to Tony Pietsch, and tonight I got his report.

Much of the 8086 software, including the BIOS supplied by Compupro, is thinly reworked 8085 (8-bit) stuff. Some was hurriedly translated. The result is fast machines with v-e-r-y s-l-o-w software.

Help is on the way. Tony has begun rewriting all the Compupro BIOSes and is slowly working his way through all the products. He recently finished a new BIOS for the Dual Processor. I installed it tonight, and it speeds things up something wonderful. By the time you read this, the BIOS I use, including all the friendly little touches like recovering from some CP/M BDOS (basic disk operating system) errors, will be standard with Compupro equipment.

It does point up a problem: if you want the absolutely latest state-of-the-art hardware, you may have to either write your own software or put up with something not so fine for a while. On the other hand, what I think of as "not so good" often turns out to be better than what most people think is "standard," and when you have really high performance hardware, you can be certain that someone will eventually develop software worthy of it.

Sweet Adeline

Alas, poor Adelle, my very low serial number Otrona, is no longer with me. She developed some problems with the disk speed regulator. Under ordinary circumstances, she'd have gone to an Otrona dealer to be fixed. The dealers simply swap out modular parts until the machine works again. This is easy enough because the Otrona is very modular in construction, and a very inexperienced technician can swap assemblies.

However, in my case Otrona tried fixing things under time pressure—I was always about to leave for somewhere—and with a minimum of inconvenience to me, meaning that Judy Seelig, from CTI (which represents Otrona in my area), would come out to Chaos Manor with new drives, new data separator chips, new software, etc., and see if that didn't solve the problem.

Adelle was an older machine. She'd been on more than a dozen trips with me, including a long train trip in Italy. All these changes were designed to bring her up to date so that she'd be similar to what Otrona is shipping now.

Sigh; while the improvements were obvious, none of those measures solved the disk speed problem. The wizards at Otrona concluded that the problem was with the disk controller chip itself, but by then Judy had had enough of driving out here every Saturday morning. She came one last time and swapped Adeline for Adelle. Then, before Adelle went back to the factory, Judy took some of the parts, like the screen, to swap into her own system: Judy's Otrona is even older than Adelle.

Thus I'm writing this on Adeline, who has been with me to all my speeches and conventions this month and has also been in nearly constant use as an auxiliary machine at home. No hitches, no glitches, no problems.

I can continue to recommend the Otrona Attache as both sophisticated and reliable. The machine is easy to use, the keyboard is reconfigurable (we have one disk set up to change the keyboard into one optimized for the WRITE text editor we favor), and the software package is very good. I carry mine to all my conferences and speeches, and just about everyone is impressed. They particularly like the Charton graphics package that comes with the Otrona.

Personal Basic

The war between Digital Research and Microsoft continues. DR is heating it up with Personal Basic, which is an interpretive BASIC for CP/M-86 and MS-DOS.

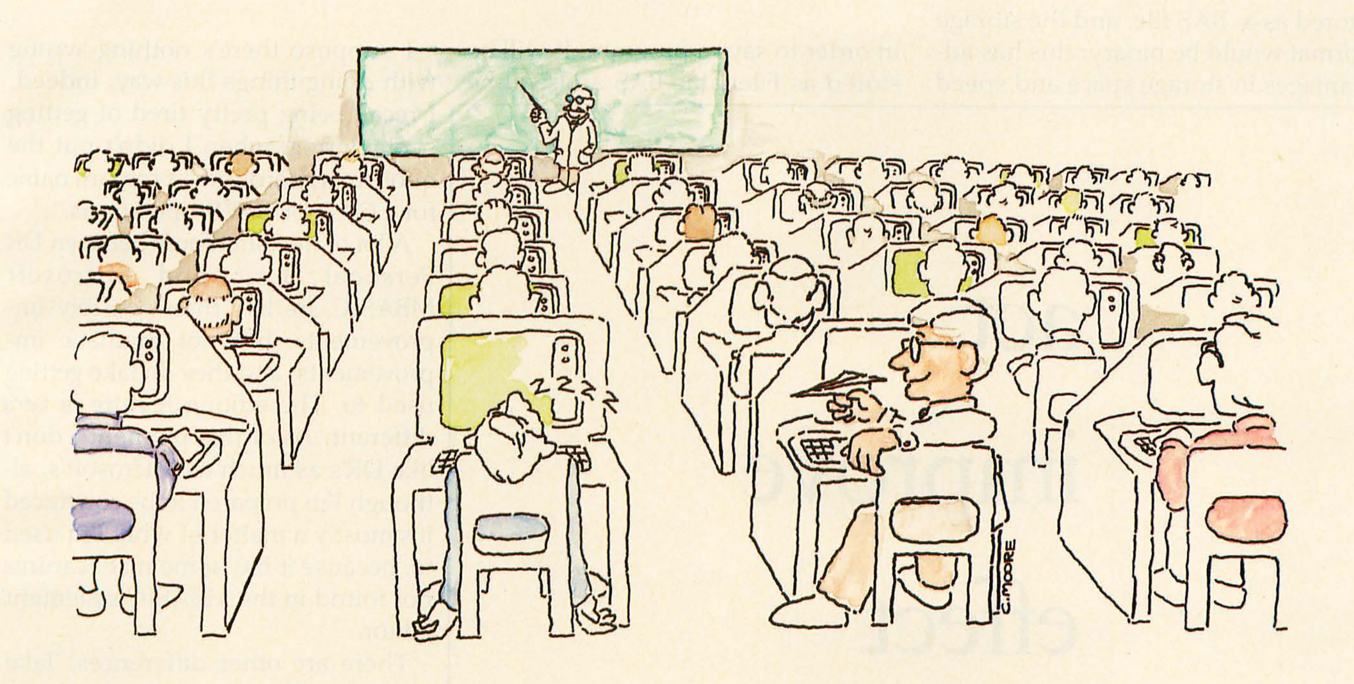
Personal Basic is a lot like Microsoft's MBASIC. That's *not a coincidence*.

On the other hand, it isn't identical. Some of the differences are significant. Others are simply annoying.

The most annoying is that there's no FILES statement in Personal Basic. Thus you cannot get a list of disk files from within a BASIC program. This seems very odd; surely Digital Research of all firms would know how to implement it. Digital's CBASIC and CB-80 don't have the feature either; I wonder if it's a policy?

I send copies of the column to the people affected. The man who wrote Personal Basic just called in some anxiety. The proper statement is DIR, which is what CP/M uses. In my

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defense, that was not listed under FILES, COMMANDS, or NAMES in the index.

A big *difference* between Personal Basic and MBASIC is the way programs are stored. MBASIC wants you to do

SAVE "D:Filename" or
SAVE "D:Filename.ASC",A

In the first line, the file would be stored as a .BAS file, and the storage format would be binary; this has advantages in storage space and speed of loading. The second line would produce an .ASC file that would be in ASCII characters, i.e., something readable by people as well as machines. To recover a program, you LOAD it:

LOAD "Filename"

Personal Basic wants you to do

SAVE Filename

in order to save a program. It will be stored as Filename.BAS and will be in ASCII format; there is no provision for storing programs in binary format.

To get a Personal Basic program back, you don't LOAD; you type

OLD Filename

and if you alter the program and want to save it, you type

REPLACE Filename

I suppose there's nothing wrong with doing things this way; indeed, I recall being pretty tired of getting syntax errors when I didn't put the quote marks around a program name for LOAD or SAVE operations.

A lot of the differences between DR Personal Basic and Microsoft MBASIC are like that: possibly improvements, but not dramatic improvements; and they do take getting used to. The editing feature is *very* different. As of this moment I don't like DR's as much as Microsoft's, although I'm prepared to be convinced it's mostly a matter of what I'm used to, because it has some nice features not found in the MBASIC statement editor.

There are other differences. Take error messages, for example. If you type something incomprehensible, MBASIC prints the message "SYNTAX ERROR." Personal Basic prints "Something is wrong," which doesn't seem a great deal more helpful; however, Personal Basic also puts a small caret (^) at the point in your command line where the interpreter got lost. This can be useful.

The best and worst parts about Digital's Personal Basic are the documents.

The best part is a tutorial that teaches a fair amount about BASIC for people who've done zero BASIC programming. It's well written and reasonably well indexed, but it's not complete and doesn't tell much about advanced features like random-access files.

The tutorial is well written in English, but that's not true for the reference manual. While better than the old Digital Research documents (the ones translated into binary and

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then Swahili before being retranslated into English), this one really isn't very good. Worse, it gets truly obscure as soon as it tackles subjects too advanced for the tutorial.

Example: random-access files.

In order to have random-access files on a disk, each file must be exactly the same length. Let's suppose each file is 50 bytes long; to find record number 30, the program need only figure out where the 1500th byte is stored in that file; it goes and gets it and presents bytes 1501–1550. Similarly, if you want to alter the thirtieth record, the program writes the new 50-byte record in where bytes 1501–1550 were on the disk. This isn't particularly simple for the program, but it's easy for the programmer.

The problem comes when you specify what those 50 bytes are, and it's particularly tough if you want to compress the data.

Data compression is complicated, but it does save time and disk space. Consider: a single "word" for an 8-bit computer consists of 2 bytes. It can take all values between 0 and 65,535 (or if we allow negative integers, between −32,768 and +32,767, more or less).

Suppose I have two integers, I1 = 2366 and I2 = 786, and I want to store them. What must I do?

If I store them in ASCII (human-readable) form, that will take 7 bytes; in addition, I will need a byte to separate the two numbers and another to separate the second number from any data following it. That's 9 bytes so far. This is the way CBASIC stores integers. It wastes space, but it's simple.

On the other hand, if I compress the data, I can do it all in 4 bytes: 2 for each integer. This requires two things: a routine that will convert my integers into binary (and back) and a way to tell my program that the first 4 bytes in a record are two integers.

Both Microsoft MBASIC and Digital Research Personal Basic do this. They do it in a slightly different way; Digital then thoughtfully supplies an option that allows you to read and write compressed data in the same format as Microsoft.

Both recover compressed data through use of the dreaded FIELD statement. The FIELD statement isn't all that awful once you understand the theory. In our example above, for instance, the FIELD statement would be

```
FIELD #8, 2 as I1$, 2 as I2$
```

because we are going to store two integers, and each requires 2 bytes for storage. We've made a sort of map.

Now we have to convert I1 and I2 into strings. A special function converts integers to 2-byte strings (MKI$). Of course they're not *real* strings; what they really are is binary numbers. They can't be real strings because they might contain goofy numbers such as 07 (which the computer interprets as a command to ring the bell). However, they're stored as strings and recovered that way.

We shove them into a record that is controlled through use of this particular FIELD associated with a particular file (#8 in this case). When we recover those numbers, the *value* of I1$ will be our original integer 2366. A special function (CVI) can convert a 2-byte "string" into an integer, and we use it: I1 = CVI(I1$).

You can have more than one FIELD. If this is confusing, don't worry about it. It's going to get worse.

Digital Research now tells us: "Reallocating field space does not cancel the original mapping; rather, the two maps coexist. For example, if you specify

```
FIELD #10, 20 AS X$, 40 AS Z$,
    10 AS Y$
```

and

```
FIELD #10, 70 AS N$
```

the first 20 bytes of N$ are also in X$, the next 40 also in Z$, and the final 10 also in Y$.

"Do not use an INPUT or LET statement with a variable that was declared in a FIELD statement. Otherwise, the variable's pointer moves to string space instead of to the buffer."

I read that five times before I could figure out what it meant. It says that if you do one FIELD statement making one allocation (mapping) and another *using different variable names* doing another, then when you read in the data from a random file you can treat it either way: if you ask for N$, you'll get all 70 bytes of the record; if you ask for Z$, you'll get the middle 40 bytes. This is useful if you don't want all your records to have identical structures. (They must, however, all have the same *length*.)

Microsoft doesn't explain it a lot better, but it does give more examples of programs making use of files, so that it's a little easier to puzzle out how it's done.

Someday a software publisher is going to explain complex stuff like file structures as well as the simple stuff. That hasn't happened yet. Digital Research's Personal Basic tutorial is a step in the right direction, but it stops far short of what's really needed. Oh, well.

When I get my PC running properly, I'll benchmark Personal Basic against Microsoft MBASIC. My subjective impression is that they're pretty comparable, but I don't have a Microsoft MBASIC that runs under CP/M-86, so I can't do actual tests yet.

CB-80 Fans Take Notice

CB-80 (compiling CBASIC) also has a means for compressing data and has its equivalent of the dreaded FIELD statement. CB-80 makes use of a Digital Research program called Access Manager; with it you can write some really complex CB-80 programs. Indeed, you can write database programs that rival dBASE II in their power and complexity.

I'll have a lot more on Access Manager in a later column; meanwhile, serious CB-80 programmers ought to be aware of it.

They also ought to be aware of Software Magic.

Al Dallas is a part-time programmer. He has developed some tools of great value and interest and markets them under the firm name Software Magic.

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utilities that let you handle data with CB-80. As an example, he gives you the function CVI(I$), which will convert a two-character string to an integer, and the reciprocal MKI$(I), which will turn an integer into a 2-byte string. There are lots of functions that call in the contents of the computer's registers; these are very useful if you're going to patch assembly-language routines into a CB-80 program.

Also included are date functions, functions for use with Access Manager, a really efficient SORT function based on the Quicksort algorithm, and other goodies. These are all made available as a library of functions you can call in a program and bring in at link time.

Al Dallas also has a book, *Inside CB-80*, that gives the addresses and actions of a whole lot of CB-80 routines; if you're heavily into mixing assembly-language routines into CB-80 programs, it is invaluable. It's a sort of advanced *grimoire* of CB-80 formulas; if you're not very familiar with CB-80, it won't do you any good.

For that matter, his Magic Library documents assume you know a good bit about CB-80 and Access Manager, although nowhere near as much as his book does. If you understand the dreaded FIELD statement, you can use Magic Library to good advantage. If you don't, you'll have to learn it elsewhere.

Items Reviewed

Access Manager — $300
Personal Basic — $150
Digital Research
POB 579
Pacific Grove, CA 93950
(408) 649-3896

Attache Computer — $2995
Otrona Corporation
4755 Walnut St.
Boulder, CO 80301
(303) 444-8100

CB-80 Book — $74.95
Magic Library — $49.95
Software Magic
11669 Valerio St., #213
North Hollywood, CA 91605
(213) 765-3957

Executive Computer — $2495
Executive II Computer — $3195
Osborne Computer Corporation
26538 Danti Court
Hayward, CA 94545
(415) 887-8080

FORTRAN 8087 Library — $200
Avant-Code
1508A Oxford St.
Berkeley, CA 94709
(415) 549-3257

Kaypro 4 Computer — $1995
Kaypro Corporation
533 Stevens Ave.
Solana Beach, CA 92075
(619) 481-4300

Modula-2 for the IBM PC — $495
Logitech
165 University Ave.
Palo Alto, CA 94301
(415) 326-3885

Problem-Knowledge Coupler — Not available
PKC Corporation
RR 1, Box 630
Cambridge, VT 05444

Super-19 — $49.95
Extended Technology Systems
1121 Briarwood
Bensalem, PA 19020

8087 Hardware Board — $495
Hudson and Associates
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Santa Clara, CA 95051
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Whimper . . .

Sigh. The pile of unreviewed—indeed, sometimes unopened—software, books, and even hardware grows daily. By its very nature, this column can tackle only stuff that I've found time to use. I cannot and will not write "reviews" from spec sheets and PR notices. Alas, that dooms me to fall farther and farther behind, but there seems no help for that. To those who sent products for review, I can only counsel patience. I'm dancing as fast as I can.■

Jerry Pournelle is a former aerospace engineer and current science-fiction writer who loves to play with computers.

Jerry Pournelle welcomes readers' comments and opinions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE Publications, POB 372, Hancock, NH 03449. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply.

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The Unix Operating System

The Unix* operating system has descended from the realm of minicomputers into the midst of microcomputers, mating advanced software features to new and powerful 16-bit microcomputer hardware designs. This multiuser, multitasking operating system developed at Bell Laboratories offers powers and abilities far beyond those of normal microcomputer operating systems. Although Unix has attracted attention for some time, access to it usually has meant being part of a research project or attending an academic institution. A growing market now takes advantage of portable software environment; the Unix operating system, written in the C language (see August 1983 BYTE), makes the move from 16-bit microcomputers to IBM mainframes and the Cray-1 a simple process.

In the near future, Western Electric (the marketing arm of Bell Labs) will offer the newest version of Unix, System 5, for the 80286, 6800, 16032, and Z8000 microprocessors. Some of the licensed versions of Unix already available for microcomputers are Xenix (Microsoft's enhanced Unix) for the Altos 586; Xenix and UniPlus+ for the Apple Lisa; 4.1 BSD Unix and Venix for Digital Equipment Corporation's Professional 350; the Fortune 32:16 with Unix version 7; Venix and Xenix for the IBM Personal Computer; and TRS-Xenix for the Model 16B. Western Electric is rumored to be planning a low-cost Unix microcomputer as well.

Computer professionals who once refused to take microcomputers seriously now take a second look at the powerful 16-bit microcomputers and the advanced software-development environment that Unix offers. Most find the vast collection of software tools (small general-purpose programs) in Unix a boon to their work. Other prominent features of the Unix operating system include its hierarchical (tree-structured) file system that allows you to break up your work area into easily identified groups, the ability to run several programs simultaneously, a flexible command shell that lets you customize the Unix system, I/O (input/output) redirection, and automatic "piping" of the output of one program into the input of the next program.

Unix also enables programs to make use of its advanced features. Applications for microcomputer Unix systems, everything from Wangwriter-like word-processing programs to accounting applications, are bursting onto the scene. Many of these are migrating from the minicomputer/mainframe environment and have multiuser/multitasking capabilities. Unfortunately, popular microcomputer programs written in assembly language may be slow in coming to Unix and hampered by a single-user, single-task orientation. The flexibility of Unix's user interface allows menu-driven command shells, such as those offered by Fortune and Altos, that make Unix simple to learn and use.

Unix systems are selling. The Internal Revenue Service (IRS) placed an order for $30-million worth of the Zilog System 8000 with the Unix operating system to use for word-processing, financial-spreadsheet, and data-management applications. (One of the largest users of Unix systems outside the Bell system is the Federal Government.) Even McDonalds, looking for a break today, is buying Unix systems. With its expanding availability on microcomputers, the second coming of Unix is here.

— Bruce Roberts

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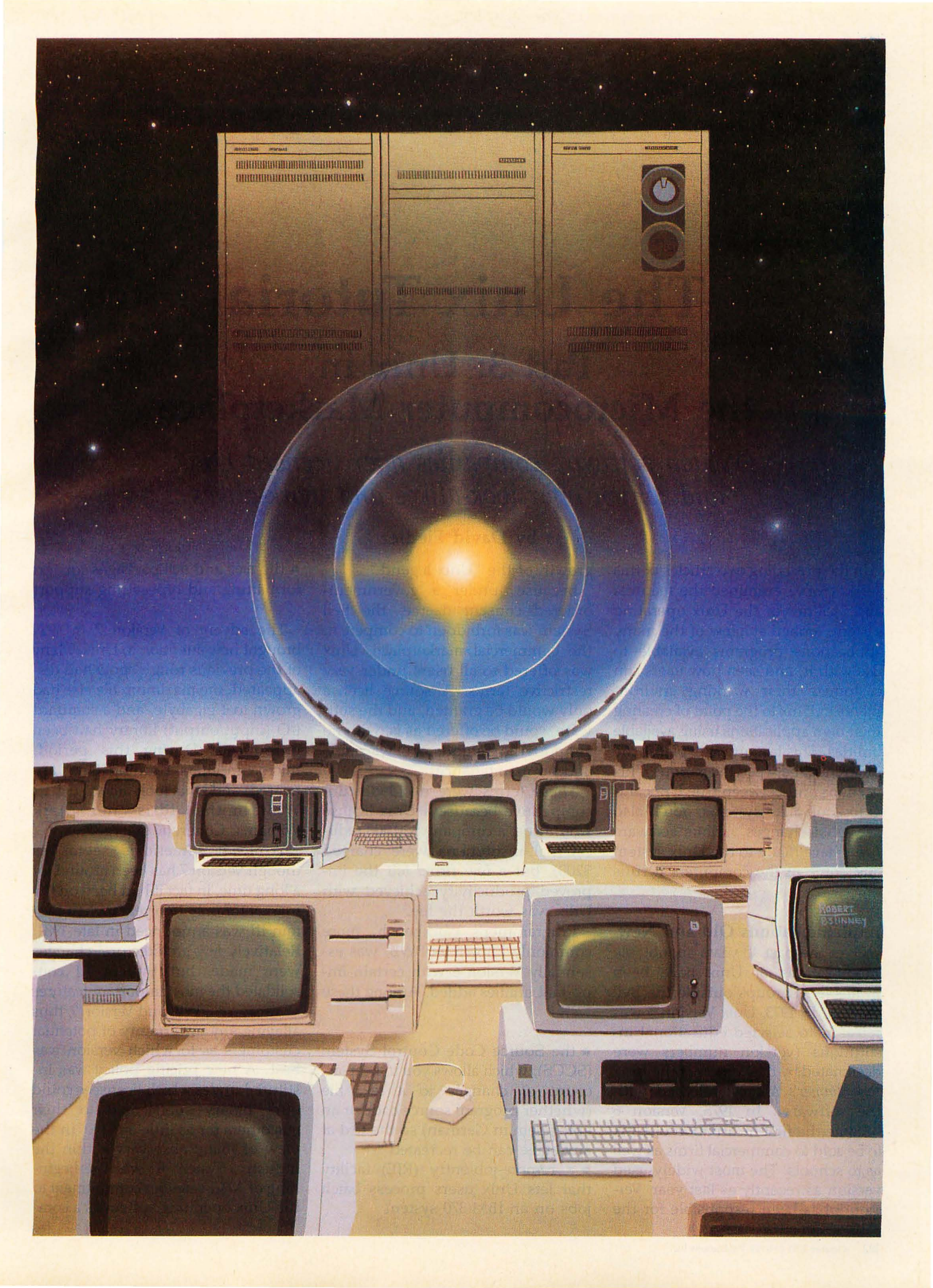
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*UNIX is a trademark of Bell Laboratories.

Painting by Robert Tinney



The Unix Tutorial

Part 3: Unix in the Microcomputer Marketplace

Which software companies offer licensed Unix and which offer look-alikes and work-alikes

by David Fiedler

In the preceding two articles of this series, we've examined the features and facilities of the Unix operating system, looked at a few of the many applications programs available to use with it, and seen how users can customize their working environments in Unix to the point of creating their own applications using available utilities. This last article explains the differences between the various Unix versions and between true Unix and Unix look-alike systems. You'll also see what changes various software firms have made to the Unix system and some of the computers it runs on.

Implementations Old and New

Over the past 10 years six notable modifications of Unix have been available to groups outside the Bell System. In 1973, Unix Version 5 was released to selected educational institutions (version numbers were designated by the edition of the *Unix Programmer's Manual* released with the software). In 1975, Version 6 became the first incarnation of Unix to be sold to commercial firms as well as to schools. The most widely used version as recently as last year, Version 6 has been responsible for the growth of the "Unix legend."

Because, under a government-ordered consent decree, the Bell System was forbidden to compete in the commercial marketplace, Unix was offered to all users under very restrictive terms. A source license only would be granted, and the software would be offered as is, with no support, no refunds, no warranty, and no maintenance.

These terms were decidedly uncompetitive because a Unix license would cost a company $20,000 (educational institutions were charged $200), but a few firms felt the improved productivity achieved with Unix was worth the fee.

Programmer's Workbench, more commonly known as PWB, was essentially Version 6 with certain important utilities added. Among these were:

- the Source Code Control System (SCCS), which allows you to keep account of changes to a text file (whether program source code or an epic poem in German) so the text at any stage can be recreated
- a remote-job-entry (RJE) facility that lets Unix users process batch jobs on an IBM/370 system
- the nroff and troff packages for text formatting and typesetting support

The advent of Version 7 in 1979 brought new attention to Unix. Many of the previous rough spots had disappeared, the maximum file size had grown to 1 gigabyte, and a standard I/O (input/output) library had been introduced. During this period, microcomputers running Unix appeared, and Unix look-alikes such as Whitesmiths' Idris and Mark Williams' Coherent emerged.

While it sometimes seems as though Version 7 has been around for a long time, in fact it had been on the market for only two years when System III was announced in late 1981. Relatively few architectural changes were made, but System III consolidated the most important features of Version 6, PWB, and Version 7, thus allaying any uncertainty of potential customers as to which version was best. A new pricing policy was instituted under which licensees could offer binary sublicenses to their customers for as little as $100. In the view of many observers within the industry, System III was the beginning of AT&T's deeper commitment to the Unix operating system as a com-



Photo 1: *Digital Equipment Corporation's Micro/PDP-11 is a microcomputer version of the original PDP-11 that Unix was developed on. The system has a 10-megabyte hard disk (with floppy disks for backup) and 256K bytes of memory.*

mercial product.

Unix System V was formally announced in January 1983, at the Unicom conference in San Diego. For the first time, users outside the Bell System would be working with the same version of Unix used by those inside, and they would be eligible for the same support, training, and service, as well. System V improvements included a redesigned file system for faster throughput and several internal changes for higher reliability. AT&T's recent announcement that it would be supporting source code licensees for Unix System V on four advanced microprocessors (the Intel 286, Motorola 68000, National Semiconductor 16032, and Zilog Z8000) gave notice to the industry that AT&T intends to keep promoting Unix aggressively in the fastest-growing segment of the market.

Outside Bell Labs

Software developers are never satisfied with anything—even Unix. From the day the first tape left Bell Laboratories, Unix has been made bigger and smaller, faster and slower, friendlier and more cryptic. Surprisingly, all this poking around by people intent on improving Unix actually yielded some useful results, including several variants that are commercially important on their own.

The noncommercial institution best known for its work with Unix is the University of California at Berkeley.

The Berkeley Computer Science Department, under the primary leadership of Bill Joy (now at Sun Microsystems), has added the following features (among others) to Unix:

- the ex and vi screen editors
- the INGRES database-management system
- a replacement for the standard Unix Bourne Shell, called the C-shell
- the general-purpose video terminal interface packages called curses and termcap
- larger disk-blocking factors and other performance improvements
- an assortment of useful general-purpose utilities such as more, apropos, finger, head, and strings (exotic names are a Berkeley hallmark)

As is typical with academic groups, the Berkeley people have been quite generous in sharing their improvements with others. While essentially the code of the Berkeley programs is in the public domain, much of it as distributed discloses Bell Labs' licensed Unix software and so may be sent only to Unix source licensees. Nevertheless, entire nine-track tapes full of this code have been sent around the world to licensed Unix sites. When distributed as a package, the Berkeley software is usually known by release numbers. The 4.1 BSD (Berkeley Software Distribution) package has been developed for the Digital Equipment Corporation (DEC) VAX line of computers, while other BSD releases are intended for PDP-11 computers.

Other groups have updated the Berkeley software in turn and made it more general in scope. Many of the Berkeley enhancements have been transported to 68000-based machines by Unisoft Systems as part of its popular Uniplus+ package. It is safe to say that a majority of Unix sites today run some programs originally developed at Berkeley. Even AT&T adopted several of these programs as part of its latest Unix System V release.

Commercial Enhancements

Interactive Systems (1212 Seventh St., Santa Monica, CA 90401) was the first commercial organization with a Unix license. The company also has the distinction of being the first organization to offer hardware and software support for the Unix system. Since 1977, Interactive Systems has been distributing its own enhanced Unix system and set of utilities consisting primarily of what would today be called office-automation software. Collectively called the IS/1 system, enhancements include packages such as multiwindow screen editors (INed), improved electronic mail programs with Telex/TWX facilities (INmail), and word-processing packages (INroff, INtext). Once exclusively tied to DEC equipment, Interactive Systems now also supports smaller computers such as the Onyx and Plexus.

Another firm that's been around a while is HCR (Human Computing Resources, 10 St. Mary St., Toronto, Ontario M4Y 1P9, Canada). HCR has achieved a reputation for customer support while emphasizing a slightly different technical path from Interactive Systems. HCR specializes in transporting Unix to different processors (such as the Three Rivers Perq machine and National Semiconductor 16032), and enhancing it with technical improvements such as graphics and text overlay software. This last feature allows people using smaller processors in the DEC line to develop and run software that would normally be limited to larger machines such as the PDP-11/70.

Venturcom (139 Main St., Cambridge, MA 02142) has developed this kind of "shoehorning" to a fine art. Its Venix system manages to bring full Unix functionality to machines as small as the IBM Personal Computer and DEC LSI-11/2. Even with its small size, Venix adds real-time extensions that make it equally useful for larger computers. Venix has become quite popular for laboratory use and has given Venturcom a reputation for small-system expertise.

Microsoft (10700 Northup Way, Bellevue, WA 98004) is a name that has long been associated with microcomputer system software, yet the firm didn't offer Unix until relatively recently. While some early versions of its Xenix system were developed by other software houses on contract, Microsoft has turned Xenix into a well-supported product with significant performance and reliability enhancements. Xenix is available on the Radio Shack Model 16 and Apple Lisa, to name just two recent versions.

The most widely used of the independently available systems is Uniplus+ from Unisoft Systems (303 West 42nd St., New York, NY 10036), a company whose specialty is the narrowest of all. Unisoft's sole business is transporting Unix System III to 68000-based computers, and the company has plenty of experience, having done this 50 times or so already. Anyone who buys a computer running Uniplus+ gets not only Unix System III but also some Berkeley enhancements as well as a few that Unisoft added. A good number of compilers and applications packages will work on any machine with Uniplus+, including the NCR Tower, the Apple Lisa, the Sun Workstation, and computers from Dual, Callan, Codata, Pixel, and Corvus.

Unix Look-alikes

All of the software systems mentioned so far are based on the original Bell Labs Unix that has been transported to a new computer or otherwise modified. There has also been a thriving business in developing operating systems that act like Unix to both the user and the applications code. Such look-alike systems occupy a significant portion of the market. When the first few Unix look-alikes were introduced, Unix sublicenses were priced in the thousands of dollars. Now that sublicense pricing has been substantially cut, look-alikes must both drop in price and have more functionality than before in order to stay competitive. Even so, it's historically been easier for computer manufacturers to deal with the look-alike vendors than with AT&T.

The first and best known look-alike system is Idris from Whitesmiths Ltd., (97 Lowell Rd., Concord, MA 01742). At this writing Idris is still compatible only with Unix Version 6, but it


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has retained a loyal following among its users due to its small size and high degree of portability. An 8080-based computer with bank-switched memory running full Idris can write a floppy disk that can be read by a VAX running Idris—something that can't generally be done with machines running Unix. Idris now runs on computers based on any of five different microprocessors.

Another prominent look-alike is Coherent, introduced a few years ago by the Mark Williams Company (1430 West Wrightwood Ave., Chicago, IL 60614). Coherent's main claims to fame are that it is fully compatible with Unix Version 7 and that it comes with almost as many utilities as does Unix. It has been transported to the PDP-11, Z8000, and 8086.

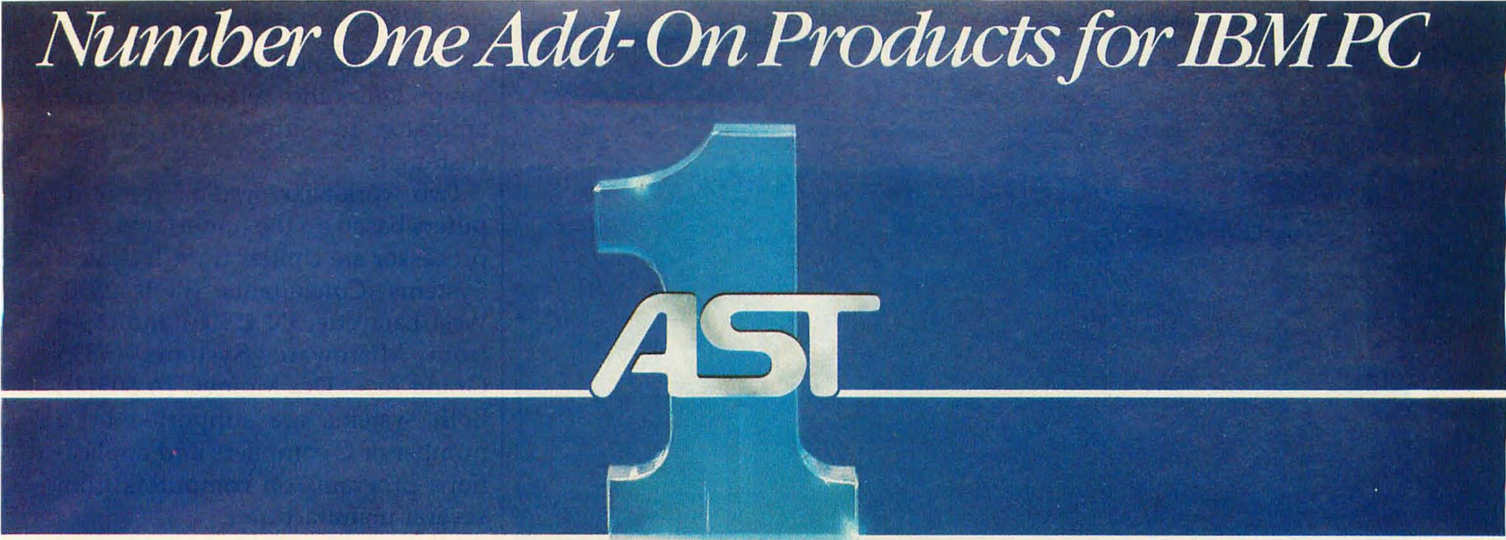
UNOS, written by Charles River Data Systems (4 Tech Circle, Natick, MA 01760), was intended as a look-alike but goes even further than Unix. While UNOS is compatible with Version 7, it also supports real-time operations for fast response where necessary, such as in laboratory work or industrial process control. CRDS's own Universe 68 computer uses UNOS, as does Motorola on that firm's Versabus-based system. UNOS seems to be limited to 68000-based systems as a design constraint.

Unix on Personal Computers

Ignoring for the moment the rapidly dropping prices in the computer world, most 16-bit computers that run Unix or Unix-like operating systems are out of the financial reach of many individuals. Never underestimate the ingenuity of software developers, though, who have made a variety of Unix-like systems targeted toward specific computers or processors. Like Unix, these systems all have hierarchical file arrangements and most are multiuser and multitasking, but some are closer to true Unix than others. While some of these systems may be able to run on floppy-disk-based computers, a hard disk or other high-speed disk drive is necessary to fully exploit the power of the software.

One of the oldest companies in the microcomputer field, Cromemco (280 Bernardo Ave., Mountain View, CA 94043), introduced its Cromix operating system on the Z80 processor in 1981. Cromix might be properly termed a *work-alike* rather than a look-alike: while its user interface, utility programs, and file system are patterned after Unix, its system calls are not compatible. This somewhat limits Cromix in the marketplace because programs written for Unix are not automatically portable to Cromix (and vice versa). Nevertheless, Cromix has been popular among owners of Cromemco equipment because it can emulate their older operating system CDOS (itself a CP/M work-alike) and yields quite respectable performance even on a Z80-based system. With the advent of its dual processor Z80/68000 board, Cromemco introduced Cromix for the 68000, also. This version has probably been less of a success due to the large number of 68000-based systems running real Unix, but it still lets you run CDOS programs because the Z80 is present. It is prob-

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able that Cromemco will eventually adopt Unix and release a Cromix emulator to support its current customers.

Two work-alike systems for computers based on the underrated 6809 processor are Uniflex from Technical Systems Consultants (POB 2570, West Lafayette, IN 47906) and OS-9 from Microware Systems (5835 Grand Ave., Des Moines, IA 50312). Both systems are supported by a number of C compilers and applications programs on computers from several manufacturers.

Micronix is available from Morrow Designs (5221 Central Ave., Richmond, CA 94804) on its Z80-based Decision One line of computers only. This system is compatible with Version 6 Unix and includes a CP/M adapter that allows most programs written for that operating system to be run.

Owners of the IBM Personal Computer and its look-alikes can rejoice in the added power they get from the 8088 processor and the ability to handle over 64K bytes of memory. While several of the transportable Unix look-alike systems mentioned previously can run on the IBM PC, two newer products created expressly for the PC are worth some attention.

QNX from Quantum Software Systems (POB 5318, Station F, Ottawa, Ontario K2C 3H5, Canada) is a work-alike operating system that has the additional features of interprocess communication, prioritized tasks, and support of disk emulators to improve system throughput. A special utility allows you to transfer files between QNX and standard MS-DOS media. A C compiler and full-screen editor are included in the $650 price.

A firm called Lantech Systems (861 Chartwell Dr., Dallas, TX 75243), which also specializes in user-transparent local-area network software, has announced an operating system called Unetix. Selling for only $99, Unetix provides a special user interface that allows you to have as many as 10 concurrently active tasks, each one executing in its own separate window on the PC screen. Any or all of these tasks can be the included MS-DOS emulator, which lets you



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run most current programs unchanged. While Unetix is a single-user system, it is compatible with Unix. Eventually, multiple PCs running Unetix will be able to share resources and communicate at high speeds.

What About Real Unix on Microcomputers?

Let's consider for a moment why Unix wasn't initially transported to machines both bigger and smaller than the PDP-11. While a college student might not need to justify spending hundreds of hours writing a C compiler for a new machine or moving Unix to that machine to satisfy his innate curiosity, the situation is different in the commercial world. The PDP-11 minicomputer line has, for years, been synonymous with good performance at a moderate price, and there were few competitors with as broad a base of installed systems as DEC had. It made little sense to move Unix to a larger computer, for what company would risk using an unsupported operating system on a $300,000 machine? As for transporting Unix to smaller systems, for an entire decade, PDP-11s and similar machines were the smallest computers that could run Unix.

By the time Version 7 of Unix was announced in 1979, it was in use on hundreds of computers both inside and outside the Bell System, and thousands of computer science students at universities had begun to ask, "Why doesn't everyone use such a terrific system?" With this ground swell of support (and the entry into the business world of those university graduates), only one thing held back the general use of Unix—inexpensive, powerful hardware.

Only in the last few years, with the advent of 16-bit microprocessors, inexpensive semiconductor memory, and high-performance, low-cost hard-disk systems, has it been possible to bring the price of a powerful computer within reach of most small businesses and even many computer hobbyists. Unix, as both the first portable operating system and the first to emphasize programmer productivity over machine efficiency, is the natural choice for such systems.



Photo 2: *Plexus' P/40 uses multiple Z8000 microprocessors to achieve performance approaching that of a VAX.*

First Implementations on Microcomputers: The Z8000

The first implementation of Unix on a microcomputer was the Onyx C8002, introduced in 1980. Based on the Zilog Z8000 microprocessor, the original Onyx was a desktop machine with an integral hard disk, cartridge-tape backup, 256K bytes of memory, and enough RS-232C ports to support eight users. At about $20,000 including the Unix operating system, at the time it was about half the price of any other computer that ran Unix. While early versions were hard-pressed to keep up with multiple users, Onyx (25 East Trimble Ave., San Jose, CA 95131) kept enhancing its machine's performance. Today's Onyx offerings are much improved, and systems in its Sundance line are available with the entire computer built into a video terminal—including the cartridge-tape backup, which has become Onyx's hallmark.

Zilog (1315 Dell Ave., Campbell, CA 95008) was not far behind in introducing a computer based on its own processor. The Z-Lab Model 20, a precursor of Zilog's current System 8000 line, marked the first entry of any microprocessor manufacturer into the Unix arena. At the time, this was especially important because it meant *factory support* for the software and hardware both. The Zilog computers run ZEUS (Zilog Enhanced Unix System).

Probably the most carefully designed Z8000-based systems come from Plexus (2230 Martin Ave., Santa Clara, CA 95050). Built around Intel's Multibus, all Plexus machines share the same basic philosophy: spare the main processor from carrying the full computing load. With this in mind, intelligent controllers are used to run the disk, tape backup, terminal ports, and Ethernet interface. The part of the operating system code that runs each set of peripherals is actually resident in the peripheral controller itself. This way, the Unix code running on the main processor needs to make only high-level requests of the controllers and can then continue processing user programs. The result is that a computer such as the Plexus P/40 (see photo 2) has performance comparable to a VAX at a fraction of the price.

An Aside on Chip Competition

Why were these machines based on the Z8000, rather than the Intel 8086 (which was available even earlier), the LSI-11/23, or the now-popular Motorola 68000? The fact that the 8086 has no memory management would allow users on the same 8086-based system to interfere with each other's programs and data; recently, however, engineers have found ways of adding this protection, and so 8086-based Unix systems have appeared. The 68000 wasn't available as a production item when the Onyx and Zilog machines were introduced, and other technical problems with this chip caused further delays in development of 68000-based computers. Perhaps as important as these factors is the similarity in architecture between the PDP-11 and Z8000: C compilers were developed quite early for the Zilog chip, a necessary first step for transporting Unix.

In spite of the early problems, the fact remains that the 68000 microprocessor can support a much larger

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linear addressing space per user than any other current 16-bit microprocessor. It can also run at higher clock speeds and support virtual-memory schemes and has 32-bit internal registers for manipulation of larger numbers than its competitors. For these reasons, and due to the relatively painless porting services provided by Unisoft Systems, the 68000 has become the most popular processor for small computers running the Unix system.

This doesn't necessarily mean that the 68000 is the best chip, though. Intel, Zilog, and DEC would be quick to point out that any software firm writing programs that could run only on 68000-based systems would be cutting out a great deal of its possible market. In general, it's almost impossible to make a blanket statement as to which of these four processors is best for high-performance Unix systems because so much depends on the overall architecture of the machine. Selecting a computer that runs Unix should be done on the basis of available software, expandability, adherence to industry standards, support, service, and price—not just the type of processor used.

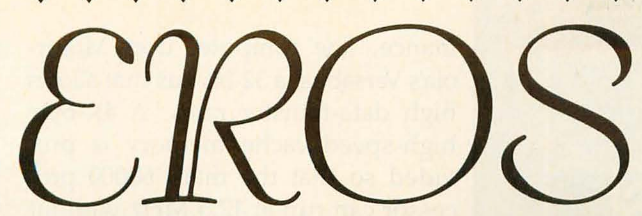
A Few 68000-Based Computers

Due to the large number of similar 68000-based systems in today's market, we'll examine only a few that are representative, innovative, or unique in some way.

Fortune Systems' 32:16 machine, for example, has won a great deal of admiration for its introduction of a menu shell that lets even novice users perform tasks ranging from file copying to system maintenance by following menu choices. Included with the Fortune machine is a powerful word-processing package and a stripped-down version of Unix. The C compiler and many development tools are available at extra cost, but because Fortune's chief market is executives, this isn't considered a great drawback. Fortune's base price of $5000 created quite a stir when the system was introduced, although this is for just a bare-bones floppy-disk-based system. Still, the Fortune (1501 Industrial Rd., San Carlos, CA 94070) is highly competitive with an attractive package and a great deal of available software.

Pixel (1 Burtt Rd., Andover, MA 01810) uses a strategy similar to Plexus in boosting the performance of its 80/AP and 100/AP machines. A TMS9900 processor handles system-level I/O (input/output) and memory mapping, a 68000 microprocessor runs user programs and the Unix system itself, and intelligent peripheral controllers pick up the rest of the load. A unique twist is the use of special video terminals that are memory-mapped into the video controller memory. The screen editor software can then manipulate strings of text in this memory directly, instantaneously updating the display without the overhead of sending the data over a serial port. Regular serial ports are supported by a separate controller.

The Universe 68 from Charles River Data Systems, as noted earlier, uses an in-house Unix look-alike called UNOS. Both hardware and software have been designed for high perfor-



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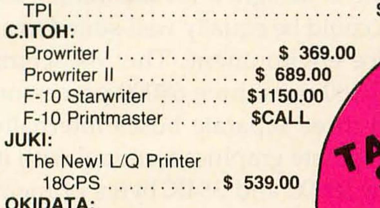
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mance. The computer uses Motorola's Versabus, a 32-bit bus that allows high data-transfer rates. A 4K-byte high-speed cache memory is provided so that the main 68000 processor can run at 12.5 MHz without wait states, which would not be possible otherwise. This architecture, according to the vendor, allows performance greater than that of a VAX-11/730 at a price comparable to a Micro/PDP-11.

Another high-performance machine is designed for laboratory use but could be equally well-suited to an office environment. The Masscomp MC-500 uses three 68000 processors and three separate buses internally. A separate graphics terminal with its own 68000 and 384K bytes of memory supports multiple processes with a joystick and special windowing software. Masscomp (543 Great Rd., Littleton, MA 01460) has modified Unix to add process locking and priority scheduling and added a virtual-memory support package from Berkeley. A multiple-window menu system and graph-plotting round out the package; data acquisition runs on a separate processor still. The result is one of the fastest 68000-based computers on the market.

As a generic look at Multibus-based 68000 computers, let's examine the Sun Workstation from Sun Microsystems (2550 Garcia Ave., Mountain View, CA 94043). The original Sun processor board was developed at Stanford University, while the board Sun itself uses has been further enhanced. Sun's long suit is a high-quality workstation with 1024- by 800-pixel graphics. The Multibus allows Sun to provide a wide range of peripherals, and the company's software expertise enables it to offer the Berkeley 4.2 version of Unix, which is otherwise available only for DEC's VAX series of computers. Virtual memory, an optical mouse, multiple screen windows, and Ethernet support options enable a user to set up one Sun or a dozen with equal ease.

What do I mean by "generic"? Sun licenses its processor board design to a number of different manufacturers,

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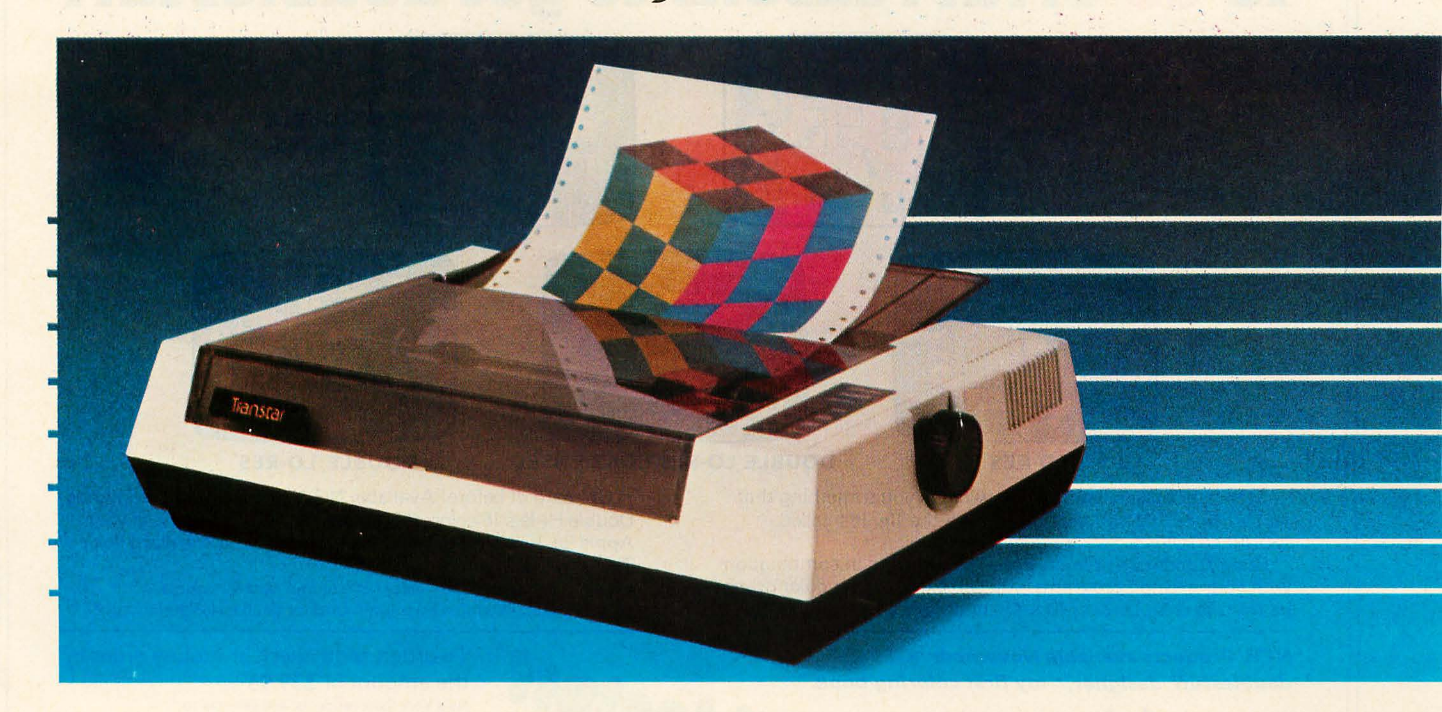
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who generally go to Unisoft Systems for their Unix license and then to any maker of Multibus peripheral and memory boards. As a result, quite a few 68000/Multibus/Sun-board/Uniplus+ systems are available, each appealing to different market needs. While selecting between these systems can be confusing, ultimately it protects the consumer in the event of a market shakeout—if one vendor goes out of business, its surviving competitors can probably support its customers.

The Intel 8086 Processor

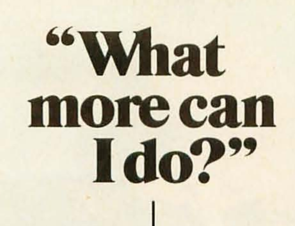
As I explained above, 8086 implementations of Unix have been delayed due to hardware considerations. Altos (2641 Orchard Park Way, San Jose, CA 95134) is the chief supplier of 8086-based Xenix machines. Its ACS8600 computer is configured around the Multibus, while its newer 586 computer is based on a single board and is small, inexpensive, and powerful. For around $8000, it provides up to six users with the power of a 10-MHz 8086 and 10-megabyte hard disk. Intel's own Unix system is aimed primarily at OEMs and built around the Multibus, so future 80286 microprocessor boards can be easily integrated.

Any mention of the 8086 would be incomplete without a reminder that the hundreds of thousands of IBM Personal Computers and its clones represent the largest potential market for Unix-like software. The IBM PC is based on the 8088, which is internally like the 8086.

Other Implementations

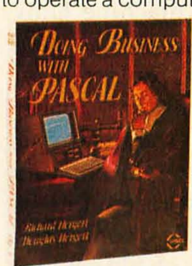
While the 8086, 68000, and Z8000 are the current "big three" in the microprocessor world, other popular single-chip processors can run Unix. The next generation of microprocessor chips includes the National Semiconductor 16032 and Intel 80286, both of which will be supported by AT&T with Unix System V. BYTE has presented in-depth technical coverage of these processors already, so I will only mention in passing that the specifications of the 16032 and 80286 are comparable to several cabinets' worth of mainframe hardware. HCR and National Semiconductor have both demonstrated working Unix systems based on the 16032. Intel is already demonstrating Unix for the 80286.

Other computers are available that use proprietary microprocessors. For example, the DEC PDP-11/23 processor can be found in both traditional minicomputer environments and in DEC's new Micro/PDP-11. The Micro/PDP-11 is housed in a thin cabinet (see photo 1 on page 133) with a 10-megabyte hard disk, floppy-disk backup, 256K bytes of RAM, and two serial ports, all for $9200. While these specifications are not unusual compared to some of the 68000-based systems, they are notable because they provide the Micro/PDP-11 user with upward compatibility through the PDP-11 line all the way up to the PDP-11/70. This can be an important consideration for an end user or OEM, especially because most software written to run on the Unix system (particularly public-domain software) was originally writ-



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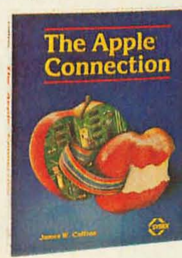


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ten for the PDP-11.

Hewlett-Packard has its own implementation of Unix running on its HP-9000, which superficially resembles an Apple except that it has three-dimensional color graphics, runs like a VAX, and costs over $64,000. Three Rivers Computer's Perq workstation supports an HCR-transported Unix with multiple windows and extremely high-resolution graphics.

Larger Unix Hosts

The PDP-11s have long been used at Bell Laboratories for software development, engineering, and office automation under Unix. Use of both Unix and the PDP-11 spread to the Bell Operating Companies for the business applications necessary to run the Bell System. The top of the PDP-11 line, the PDP-11/70 minicomputer, requires several 6-foot-tall racks of equipment; this machine is rapidly becoming obsolete due to the newer additions to the VAX line as well as the more powerful microcomputers.

The VAX is currently DEC's most powerful line of computers. A true 32-bit machine with virtual addressing capabilities, the VAX has also become pervasive in the Unix world. Specific versions of Unix have been written to take advantage of VAX architecture: Berkeley's 4.2 BSD and a previous offering from AT&T known as Unix 32V. Other firms, such as HCR with its Unity system, have made Unix facilities available to users of Unix-based software "on top of" DEC's own operating system for the VAX, known as VMS.

The first non-DEC machine Unix was transported to was an Interdata 8/32. Interdata was replaced by Perkin-Elmer (2 Crescent Place, Oceanport, NJ 07757), the first minicomputer manufacturer to support Unix. This firm's most recent line of machines, the 3210 series, comprises fast 32-bit computers of file-cabinet size with prices comparable to high-end microcomputers (in the $50,000 range).

For those with budgets in the $300,000 range, Gould S.E.L. (POB 9148, Ft. Lauderdale, FL 33310) has its

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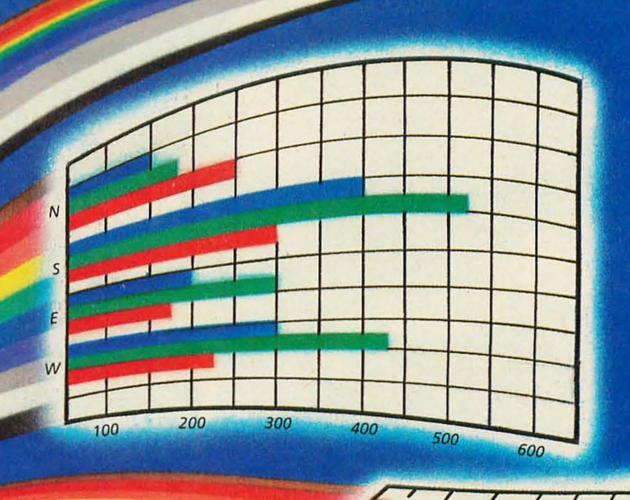
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Concept 32/87 series. At this writing, these are the most powerful computers running Unix with full factory support. Gould is rapidly becoming an important factor in Unix circles due to its commitment to Unix and wide-ranging product line.

Last but not least in the minicomputer world, we have the IBM Series 1. While this is the first computer IBM has offered with Unix support, it surely won't be the last. Apart from its Personal Computer, IBM is expected to supply its 4300 mainframe series with Unix as well.

Mainframes and Supercomputers

The customers for this class of machines generally want operating systems with more controls, checks, and audit trails than Unix has: it's rare that a firm buys a mainframe just to support software development. Even so, Unix has been available on the famous IBM/370 computers for years, although not from IBM, and not commercially; Bell Labs transported it a while back to explore the ramifications of running Unix on these behemoths. Amdahl, the maker of the original IBM look-alikes, announced in 1981 that it would support Unix on its System 470 series.

Any other mainframe Unix implementations are for now at the rumor stage only. Current rumors include not only the IBM 4300 series but also the next version of the Cray supercomputer—without doubt the world's fastest. While these developments are indeed likely to occur, they point up a certain controversy: should every computer everywhere really run Unix? Is it necessary, desirable, and even possible?

Competition from Other Systems

Unix, if it is to be considered a candidate for the "universal" operating system, should be compared with every operating system on every computer. In the interest of brevity I will limit the discussion to some of the most popular of today's operating systems for microcomputers. Minicomputers and mainframes are in many cases capable of supporting several operating systems simultaneously; nevertheless, these larger machines are more likely to use the manufacturer's own operating system because of the larger installed base of software.

In the first article of this series, I examined the CP/M operating system and mentioned that it was limited to 8080-compatible processors. While this is true for the most widely used version of CP/M (CP/M 2.2, also called CP/M-80), Digital Research Inc., the creator of CP/M, has also been selling versions of CP/M that will run on other processors: CP/M-86, CP/M-8000, and CP/M-68000. The user interface for these versions is similar, but it is not always possible to simply recompile all your programs written for CP/M-80. This is because fewer high-level language compilers are available for the 16-bit versions of CP/M, limiting the portability of applications programs.

CP/M was not designed as a portable operating system (although it was written in the high-level language PL/M, oddly enough), so the

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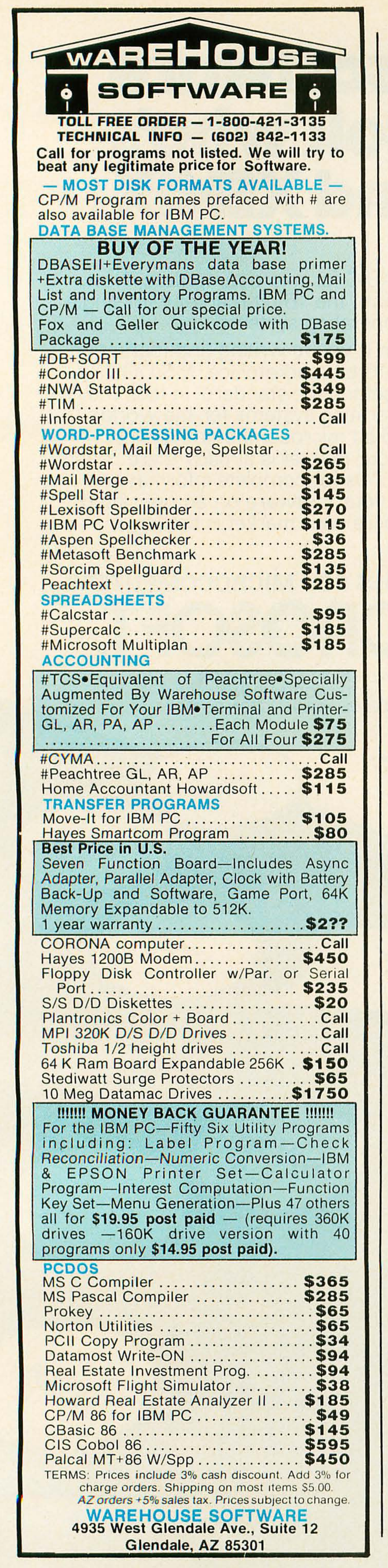
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transported versions lack the universality that originally made CP/M so popular. Also, CP/M is a single-user, single-tasking system with relatively few built-in system utilities. In fact, many of the programs sold for use with CP/M-80 are utilities that, when added together, give that system many of the features of Unix. The only problem is that by the time you've purchased all these programs, you're short of both money and user memory. While CP/M-Plus will provide more performance for 8-bit machines, even the newer Concurrent CP/M for 16-bit processors is only a single-user system.

For these reasons, I don't expect CP/M to provide a serious challenge to Unix in those markets appropriate for Unix unless its capabilities are enhanced significantly. Even then, CP/M as a Unix-like system may find only the same limited acceptance as other Unix-like systems do today.

What of MS-DOS, Microsoft's operating system for the IBM PC that has become a de facto standard on 8086-based computers? Microsoft's plans for MS-DOS include gradual upgrades so that single-user MS-DOS will be virtually indistinguishable from single-user Xenix. A case in point is the current version of MS-DOS known as 2.0. This system has a hierarchical file structure, I/O redirection, and supports shell-like command files. Because Microsoft owns both Xenix and MS-DOS, it's a smart move on the company's part to coordinate an eventual merger.

However, this merging muddies the comparison. Clearly, if MS-DOS is to become like Xenix (and therefore like Unix), it will no longer be considered competition. MS-DOS is also limited to 8086 and 8088 processors, so let's look upon Xenix as the multiuser MS-DOS of the future and call this a battle already won by Unix.

The UCSD p-System is one of the few truly transportable operating systems on the market that doesn't resemble Unix. Sold by Softech Microsystems Inc. (16885 West Bernardo Dr., San Diego, CA 92127), the p-System's most distinctive feature is that programs written for it have close to full object code compatibility regardless of what system they were written for. Programs don't even have to be recompiled to run on a different type of computer, as long as the p-System is supported on both machines. Currently, the p-System runs on a wide range of processors, including the 8080/Z80, 8086/8088, 6502, 6809, 68000, TMS9900, LSI-11, and PDP-11. However, the price you pay for this portability is speed.

The p-System depends on a special type of machine-independent object code called *p-code*. While p-code is the same for all machines, it has to be translated into the object code for any particular machine so it can actually execute. The catch is that this translation is done while the program is running: it's interpreted, the way most BASIC language implementations work. Also, the p-System is multitasking but not multiuser. The p-System doesn't seem to have made much of a dent in CP/M sales and shouldn't hold Unix back a whole lot, either.

There's another operating system being talked about a great deal lately that's considered by many to be new, but it was actually developed quite a while ago. Like Unix, it's both multiuser and multitasking, programmers who use it become inflamed with religious zeal, and many small computer makers are beginning to use it. It's called Pick.

Pick Computer Works of Irvine, California, licenses the Pick system on a select group of minicomputers and a growing number of high-performance microcomputers. Pick's chief strengths are that it was developed specifically with commercial applications in mind (it's essentially built around a database-management system) and that it has a strong base of applications software already in place. Pick has already proven itself a worthy competitor of Unix because it's been implemented on a few computers that don't have Unix also.

The Pick brigade is small but growing. A great deal depends, oddly enough, on the Unix software houses: if the visible output of Unix-based applications doesn't grow, word may spread that there's no software available for Unix. This would

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cause a certain amount of disenchantment among *potential* Unix end users and be a boon for Pick. However, this is all just window dressing because already many more applications programs are available for Unix than for Pick. The Perchwell Corporation predicts that Pick will be the system of choice among OEMs who choose not to use Unix for proprietary reasons and that Pick will be successful in this second-fiddle role in much the same way that Oasis or Turbodos relates to CP/M.

Competition from Look-Alikes

If Unix functionality and compatibility are the only way to go, then it seems reasonable that the biggest competition for standard (i.e., AT&T) Unix will not be from other operating systems but from the look-alikes and derivatives. Here, we're talking about real money competition rather than "which operating system is better" because all these implementors tacitly agree that Unix is better.

The biggest question mark is Microsoft and its Xenix. Apart from the success Xenix has had with hardware manufacturers such as Altos and Radio Shack, the tie-in to IBM with MS-DOS means that Microsoft is in a good position to bid on any possible IBM PC contract. It's hard to predict whether IBM will support a Unix-like system on the current PC or wait for its upcoming 80286-based model. AT&T itself could have the advantage in the latter case (because it will have the rights to the "official" 80286-based Unix), so IBM could well prefer to deal with AT&T directly.

IBM has proved unpredictable before, however, and might rather go with Microsoft because it is smaller. The smallest company of all here would be Venturcom, which has the advantage that its Venix system is well thought of by IBM. In the absence of any decision by IBM, the situation would be thrown open to all the current PC-compatible systems. Of these, Unetix and Venix would most likely end up ahead: the first for its price and the second for its embedded applications and heritage.

Look-alikes in general have some of the same advantages as systems such

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as CP/M and Pick. Some manufacturers will go for these systems specifically to have something they can control a bit better (some will do it just for the price differential). Uniplus + will continue to be popular as long as the 68000 is king; it's an easy way to get into the market.

The most important factor will be compatibility; look-alikes will survive only as long as applications software is available for them. If the differences between a look-alike and the original mean that software has to be transported to the look-alike, it won't be worth the trouble to use the look-alike in the long run. An effort is being made among these vendors to determine a standard system interface. This should go a long way toward keeping them all in business.

An interesting factor is that AT&T's size will actually promote competition. Because it's so big, it can't possibly do everything, and if it could, it certainly couldn't do everything right for everybody. And now that people are realizing how popular Unix is becoming, they're beginning to leave the universities, the Bell Operating Companies, and Bell Labs. They all have their own ideas on how to improve Unix and write applications for it, and you'll be seeing many new companies spring up from this "underground" base of talent.

Conclusions

We've seen that it's technically possible for just about any machine with a 16-bit processor (or larger) and a reasonable amount of disk and memory capacity to support Unix. And in spite of the other operating systems around, computer firms appear to be hedging their bets: they may support other systems, but a Unix implementation always happens to be available. It seems necessary, at least in the market for today and for the foreseeable future, for many computers to run Unix.

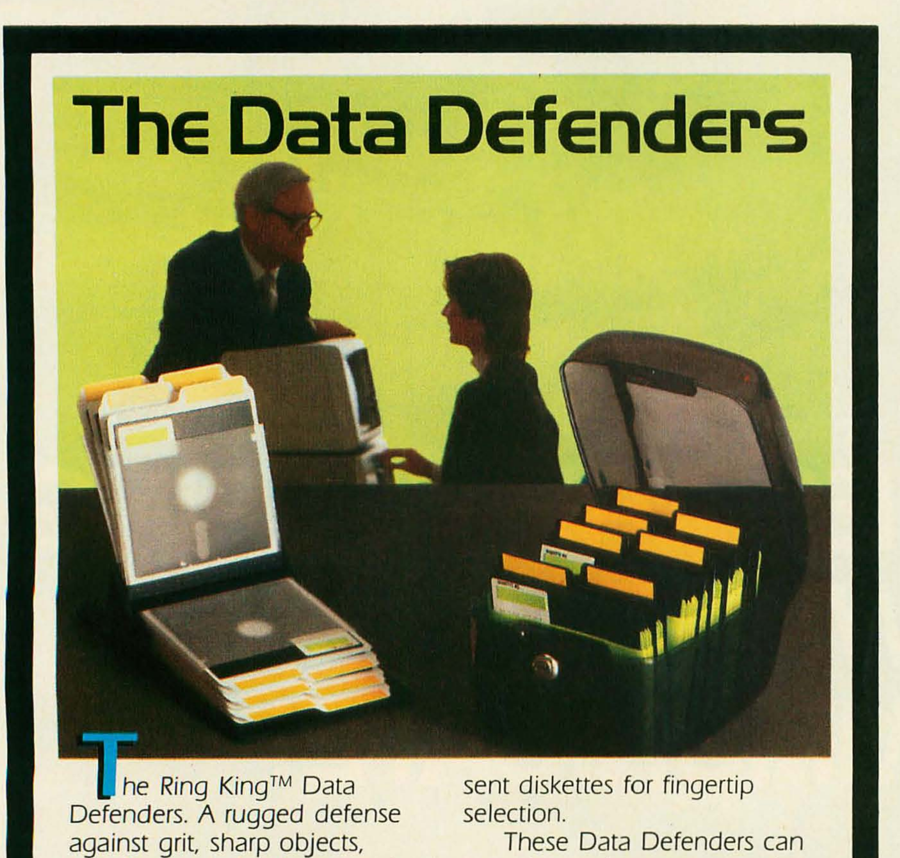
But do we really need Unix on every machine? Industry analysts have called for a universal user interface that would let people move to a new job without having to relearn all their computer skills. This would go a long way toward the dream of computer literacy for the masses. The rapid proliferation of Unix seems to indicate that it might be a candidate for such an honor. ■

A free, detailed set of charts listing companies mentioned in this article, their addresses, and their products, can be obtained by sending a stamped, self-addressed envelope to Unix Charts, c/o Infopro Systems, POB 33, East Hanover, NJ 07936.

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David Fiedler (Infopro Systems, POB 33, East Hanover, NJ 07936) is the editor of the monthly newsletter Unique: Your Independent UNIX and C Advisor *and the magazine* UNIX Review. *He is also an analyst for The Perchwell Corporation, a consulting firm assisting management of companies using Unix.*

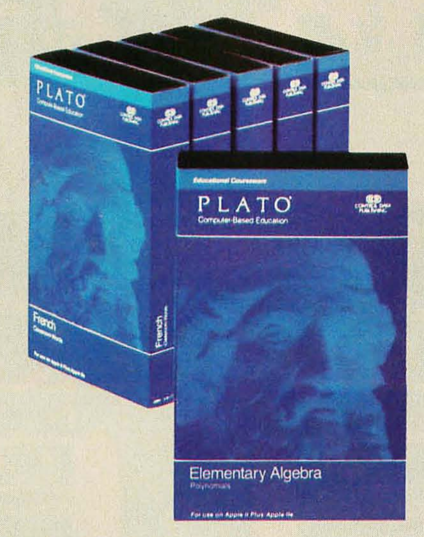


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Unix and the Standardization of Small Computer Systems

Developed at Bell Labs around 1970, Unix is heavily influencing the assimilation of systems and applications software

by Jean L. Yates

Small computer systems were first standardized at the hardware level, with standard microprocessors, buses, peripheral chips, and peripherals providing increasingly low-cost systems. Major hardware vendors are now working with software houses to standardize operating systems and applications so that microcomputers and mainframes can communicate on program, file, and message levels. Within the next three years, the most commonly used type of personal computer will achieve multiprocessing capability, and the number of networks and multiuser systems will grow dramatically. The Unix operating system and the C language will be major factors in the standardization of file handling and compatibility across small systems and mainframes.

Time of System's Popular Use	1979	1981	1983	1985
Type of Computer	Vector Graphic System B	Onyx	Altos 586	a future system
Storage Capacity (bytes)	56K	256K	512K	2 megabytes
Microprocessor Used	Z80	Z8000	8086	68010, 286, 386, or 32032
Operating System	CP/M	Unix	Xenix	a virtual type
Number of Users	1	1 to 6	1 to 6	1 to 25
Storage Media	two 500K-byte floppy disks	tape and 5 to 10 megabytes on hard disk	1 megabyte of floppy-disk backup for a 10-megabyte hard disk	a 2-megabyte backup for 50-200-megabyte hard disk
Price	$5500	$15,000 to $30,000	$8000	$6000

Table 1: *As great strides are made in improving hardware capabilities, prices of small-business computers will return to 1979 levels.*

Table 1 portrays the rapid decline in price and accompanying increase in hardware capabilities of typical small-business microcomputers over the past four years. In 1979 the Vector Graphic System B was one of the most popular small-business systems. With 56K bytes of memory, a Z80 microprocessor running CP/M, single-user capability, and 500K-byte floppy disks (very high density for its time), the system sold for $5500.

By 1981 a new generation of computers with increased hardware capability and a corresponding higher price became popular. Onyx's 8002, for example, which could handle up to six users, offered 256K bytes of RAM (random-access read/write memory) with a Z8000 16-bit microprocessor and the Unix operating system. A tape backed up its 5- to 10-megabyte hard disk, and the system sold for $15,000 to $30,000, depending upon the configuration.

Today, products such as the Radio

Shack TRS-80 Model 16 and the Altos 586 have radically reduced the price of Onyx-type systems. The Altos 586, which provides 512K bytes of RAM, an 8086 microprocessor, Microsoft's Xenix version of the Unix operating system, one- to six-user capability, and 1 megabyte of floppy-disk backup to a 10-megabyte hard disk, sells for about $8000, depending upon the configuration. Table 1 points out that with $6000, users could purchase much more computing power in 1983 than in 1979. In addition to the Altos 586, the TRS-80 Model 16, Fortune's 32:16, IBM PC-XT, and Victor 9000 are examples of systems offering high levels of hardware performance for a comparatively low price.

By 1985 a small-business microcomputer selling for $6000 will provide 2 megabytes of memory, use a 32-bit microprocessor such as the 68010 or the 386, and offer a virtual operating system. (Today, such systems, which let you run other systems over them—as you would applications programs—are available only on 32-bit superminicomputers and mainframes.) This hypothetical 1985 system should let up to 25 users utilize a 2-megabyte floppy-disk, tape, or optical-storage backup and 50 to 200 megabytes of hard-disk storage.

Increasingly, operating systems for small-business computers are being written in higher-level programming languages such as C. These systems offer networking and other communications capabilities, hierarchical file systems, and disk sharing. Unix is often the vehicle used to take business applications from minicomputers to microcomputers. Unix and the C language are increasingly evident in standard software for 16-bit micros.

The Drive to Standards

The standardization of hardware has been clearly demonstrated, and standardization of the operating system is evident from the popularity of CP/M, MS-DOS, and Unix. These three operating systems are keys to large libraries of applications software. Currently, the big push in standards is to connect microcomputers to minis and mainframes. Although the hardware and operating-system levels are themselves problems, the biggest problem is connecting packaged applications such as Visicalc or word processors to mainframes and allowing files to be shared and manipulated from mini- or mainframe-based data storage to micro workstations.

Licensed Unix sites will number 1.4 million by 1987.

Available for micros, minis, and mainframes, Unix becomes a viable standard for file and program compatibility.

Standardization Areas

To connect micros to mainframes, standardization must occur at several levels. Although it might initially appear that standardization should occur at the hardware-connection level, most of the standardization needed for software transfer to mainframes and across different types of micros occurs at the operating-system level. And in many cases, Unix is the standard by which new operating-system developments are being compared.

At the operating-system level, the file format, or the way in which files are held on a floppy disk, is undergoing considerable standardization. The type and order of bits at the beginning and end of files and the way in which data is held in the file maintain, in many operating systems, the same format that Unix has historically used. Unix holds almost all data and text files in standard ASCII (American National Standard Code for Information Interchange) code and does not encode or encrypt data unless it proves absolutely necessary. Great flexibility in moving or manipulating files is thus maintained. You can observe most Unix files with a text editor and see what they contain, unlike binary or hexadecimal files, which produce only dashes and blips on the screen.

Command names, directory structures (specifically the hierarchical directory of Unix), I/O (input/output), and record locking are other areas of standardization on which Unix is having a great impact. Language (gross and subsets) syntax and function call names and arguments are other areas where the C language

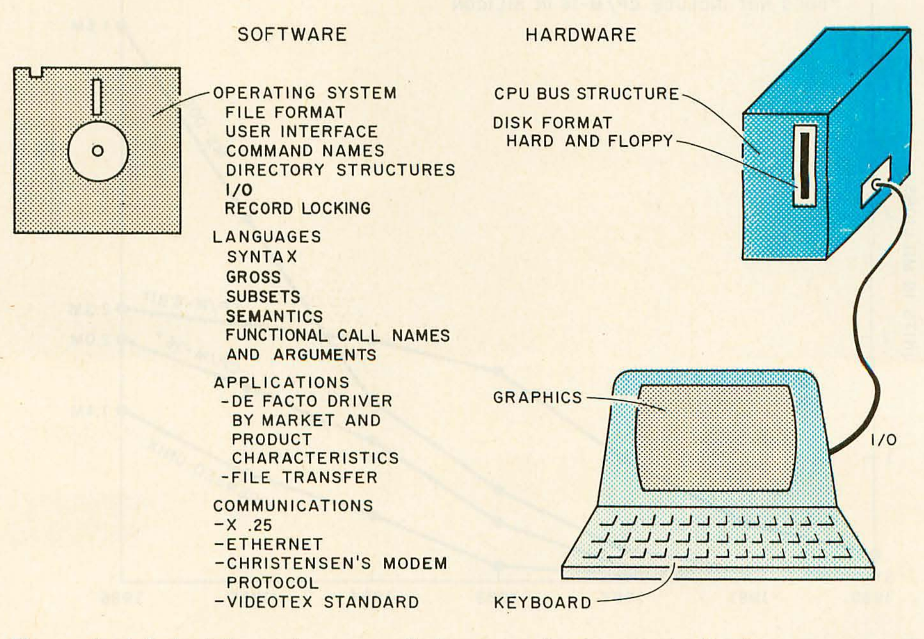


Figure 1: *A look at the various areas that are experiencing standardization.*

and the system calls of Unix are evolving.

At the applications-software level, drivers for terminals and disks are standardizing as vendors realize the importance of offering a standard interface for easy transfer to their computers. File transfer from micros to mainframes is also becoming standardized. A format growing in popularity is Visicorp's DIF, which has been adopted by most spreadsheet-application vendors as the standard way to hold and manipulate spreadsheet data. For more information on this data-interchange format, see "DIF: A Format for Data Exchange between Applications Programs" by Candace E. Kalish and Malinda F. Mayer (November 1981 BYTE, page 174). Some of these standards are shown in figure 1.

Standard Operating Systems

The three major families of standard operating systems are MS-DOS, CP/M, and Unix. Figure 2 shows that MS-DOS is expected to be the market leader for the next three years. CP/M-80 and CP/M-86 together match the market size of MS-DOS, and the recent Visicorp/Digital Research alliance could push CP/M-86 up near the MS-DOS level. (Visicorp and Digital Research have agreed to place Visi On, Visicorp's user interface, over Digital Research's operating systems and to provide language and tool support for each other's products.)

The number of licensed Unix installations by the end of 1986 will be only 1.4 million, although pending announcements by small-system manufacturers, specifically Commodore, could boost that figure by another million units. Although the number of Unix licenses is less than that of MS-DOS or CP/M, those operating systems' sales figures (in dollars) are nearly equal. An average Unix-based system is a higher-performance micro or mini that can accommodate multiple users and costs more than a system running MS-DOS or CP/M.

Table 2 shows the number of new Unix licenses and the dollars that will be spent on licensed mainframes, minicomputers, and microcomputers from 1981 through 1986. The micro-

Unix for Microcomputers—A History

Developed by Bell Laboratories around 1970 for use on minicomputers, the Unix operating system has evolved into a multiuser system for 16-bit business microcomputers. In contrast to the Apple II, which uses a 6502 8-bit microprocessor, or the TRS-80 Model 1, which incorporates a Z80, a 16-bit microcomputer includes such microprocessors as the 8086 or the 68000. As a multiuser system, it lets many users interact simultaneously with the computer from different terminals.

Unix is actually an operating-system chameleon; its many forms and flavors are the result of adapting research and development software to commercial uses. Today, the operating system is distributed by more than 100 computer and software vendors. Some versions are specifically for use on microcomputers, and some forms of Unix have been reworked to meet the needs of such users as engineers, typesetters, and government agencies.

The majority of Unix users are microcomputer owners whose specific needs differ from those of the traditional computer user. Many find themselves confronting a multiuser operating system for the first time and are thus unfamiliar with the special software-maintenance requirements such systems involve. Because Unix was not developed for the uninstructed user, a beginner cannot take advantage of much of its computing power.

Two companies in particular are promoting the adaptation of Unix for microcom-

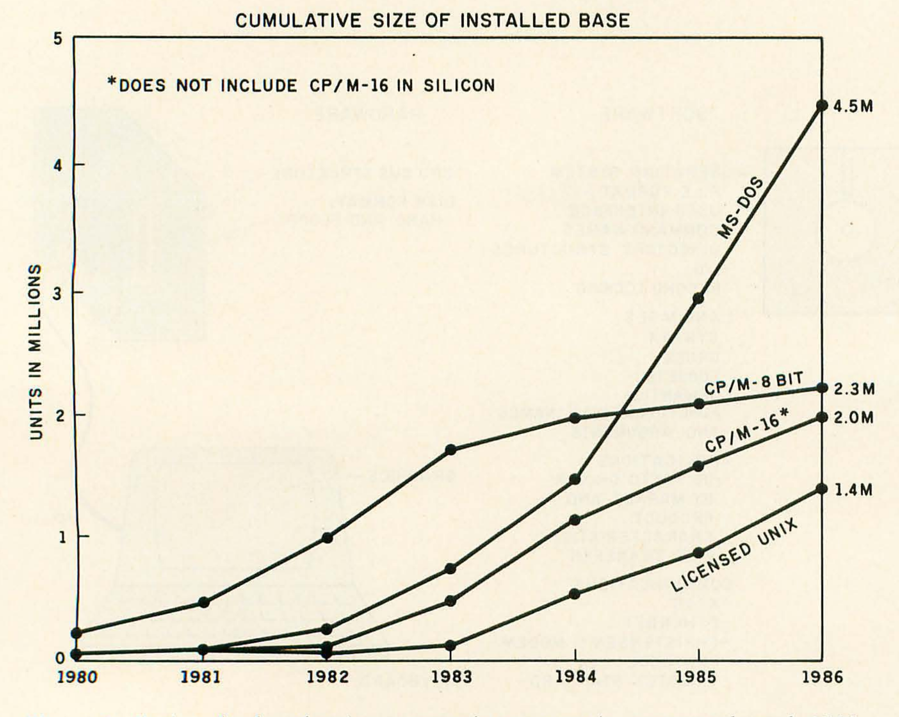
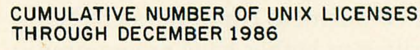


Figure 2: *Projected sales of major nonproprietary operating systems through 1986.*



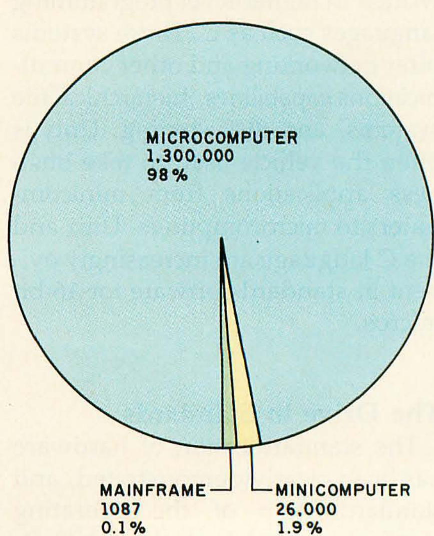


Figure 3: *At the end of 1986, mainframe and minicomputer licenses for Unix will represent only 2 percent of the total number issued.*

puters: Microsoft Corporation of Bellevue, Washington, with its Xenix operating system for use on 8086-, Z8000-, and 68000-based microcomputers, and Unisoft Systems of Berkeley, California, which makes a system for 68000-based microcomputers. Other vendors have brought Unix to such computers as the Onyx and Plexus.

From its origins as a software program for text editing and formatting, Unix has evolved over a decade to the point that it is now a massive set of programming tools for software development, text preparation, and communications in addition to its ability to perform operating-system functions. The developers of Unix pioneered the concept of software portability—the capability of operating on various types of computers. This concept was introduced by the Bell System because it didn't want to have to write new software when it decided to use a new type of computer. Portability has proven to be a major selling point for Unix.

The C Language

Unix is written in the C language (see the August 1983 BYTE), which was also developed at Bell Laboratories. Machine-independent C was designed for large software programs that can be used on various types of systems; Unix derives its portability from C. Many microcomputer companies develop applications software in C, often using Unix tools, which are specifically designed for efficient C programming.

Bell Labs has continued to enhance Unix software and releases periodic updates. With its release of System V earlier this year, Bell demonstrated support of versions for microcomputers in addition to its line of minicomputer-oriented products. Bell may decide to offer additional microcomputer and business software in the future. Today, more than 200 independent software vendors offer Unix applications packages for spreadsheet, accounting, inventory-control, and other business uses.

computer market represents the bulk of Unix units and dollars, although the minicomputer sector is by no means insignificant. Figure 3 diagrams the predicted preponderance of Unix licenses for microcomputers through December 1986; those licenses will account for 98 percent of the total issued.

The Shift to Commercial Use

From 1980 to 1986, Unix end users will change dramatically. As figure 4 indicates, Unix users in 1979 were almost entirely from research facilities and universities, the Bell System, or the government/military. At that time, commercial users made up only 3 percent of the total. By the fourth quarter of 1983, however, 93 percent of an estimated 100,000 total Unix sites will be commercial.

As the Unix market changes to meet commercial needs, it will also serve a vertical market, one that provides specialized software to such diverse fields as banking and medicine, which implement Unix yet cannot share applications packages.

Annual Distribution of New Unix Licenses

	1981	1982	1983	1984	1985	1986	Total
On mainframes							
$ Million	3.7	7.6	42.2	88.3	111.9	119.1	372.8
Units	9	20	115	248	325	370	1087
On minicomputers							
$ Million	220.5	357.0	542.0	838.0	1015.0	1053.0	4025.5
Units	1310	2200	3375	5050	6710	7690	26,335
On microcomputers							
$ Million	31.4	447.3	1588.8	3437.7	4996.1	5256.5	15,757.8
Units	1320	23,710	110,600	269,800	414,800	495,500	1,315,730
Grand total							
$ Million	255.6	811.9	2173.0	4364.0	6123.0	6428.6	20,156.1
Units	2639	25,930	114,090	275,098	421,835	530,560	1,343,152

Table 2: *Demand for Unix licenses for microcomputers will skyrocket over the next three years.*

The Vertical Unix Market

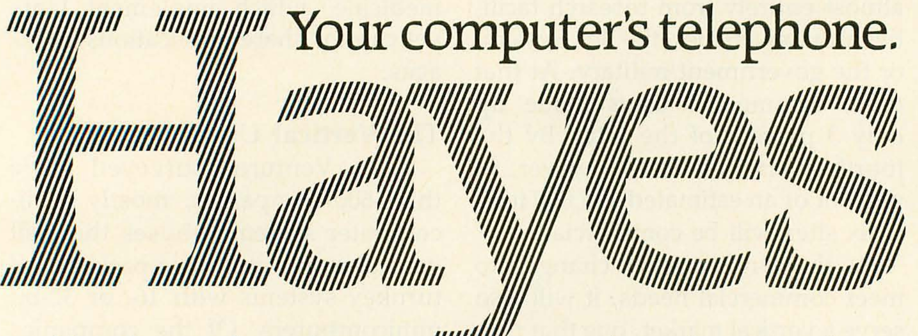
Yates Ventures surveyed more than 600 companies, mostly minicomputer systems houses that sell vertical-market software packages as turnkey systems with 16- or 32-bit minicomputers. Of the companies surveyed, more than 400 have products that could run under Unix; 250 expressed an interest in or said they planned to offer their software on a Unix system.

The vertical market's potential for Unix varies from area to area. One of the largest areas is the banking industry, which is particularly interested in lower-cost fault-tolerant or nonstop systems. Fault-tolerant systems provide built-in mechanisms that work to prevent breakdowns. Tandem originally had the market for nonstop systems to itself. Such companies as Auragen, Bunker-Ramo, Parallel, and Tolerant Transaction Systems, however, are now competing with Tandem and offering much less expensive computers. These manufacturers are providing a viable alternative for those sectors purchasing nonstop systems. Many of these groups simply cannot afford the bigger Tandem systems.

Hank: Here's the report you've been waiting for. Hope you put your system on automatic and didn't wait up.

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And if you need it, there's always "help." One of several special functions assigned to IBM function keys, this feature explains prompts, messages, etc. to make communicating extra easy.

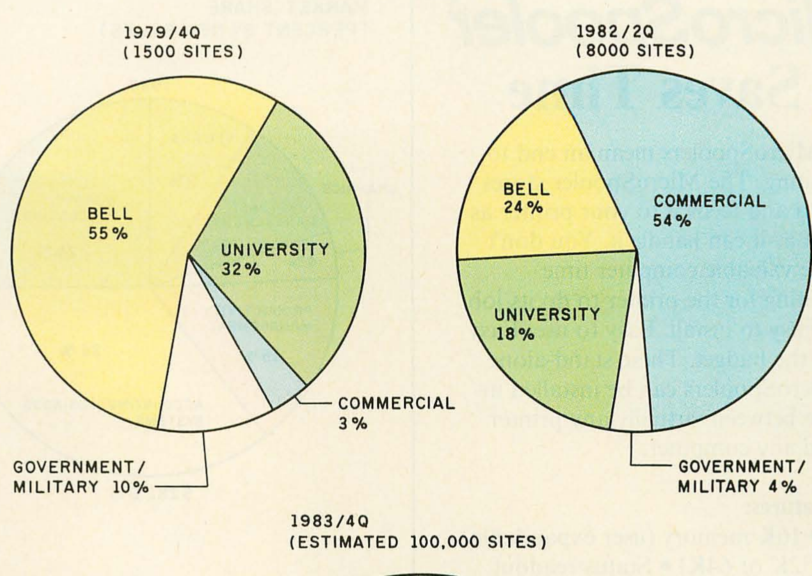
With Smartcom II, it is. The program remembers communication parameters for 26 different remote systems. Just punch a key, you're all set.

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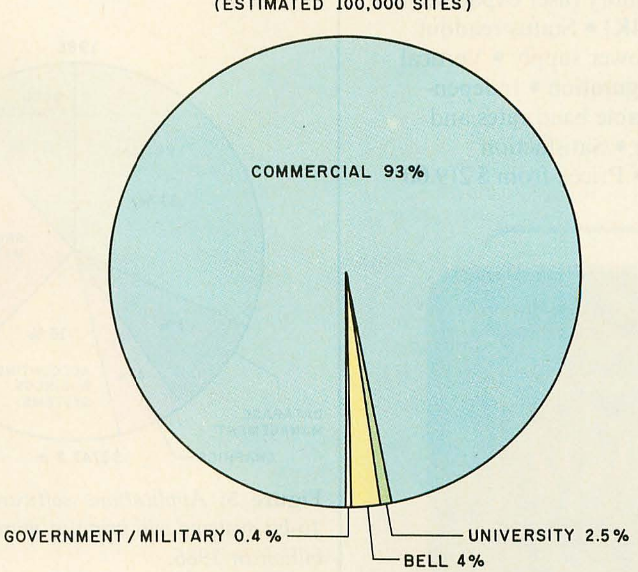


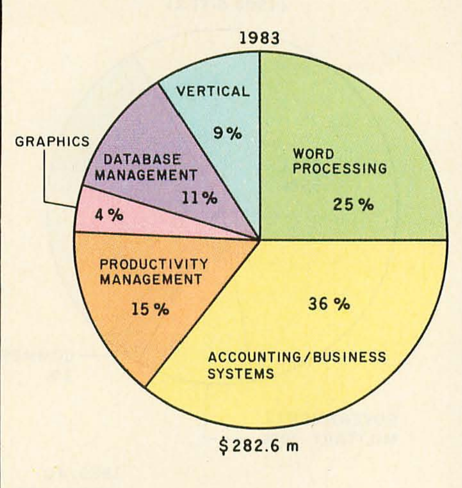
Figure 4: *These pie charts show a projected shift in the type of user implementing Unix. By the end of this year, approximately 93 percent of licensed sites will be devoted to commercial applications.*

The Market for Unix Applications Software

Based on marketing interviews it regularly conducts, Yates Ventures has projected what types of applications software will make up the total Unix market of $282.6 million in 1983. Accounting and business-systems software, for example, will represent 30 percent of the Unix market. Word-processing packages will hold second place with a 25 percent share. The productivity-management sector, which includes such packages as electronic spreadsheets, will represent 15 percent. Figure 5 compares the applications-software-market breakdown for 1983 with projected figures for 1986.

By 1986 vertical-market packages will dominate a $1.7 billion market, representing 37 percent of the total. Productivity-management packages will make up 26 percent of the overall market, with accounting and business-systems software running third at 15 percent. Figure 6 depicts the shift toward verticality—Unix applications-software vendors will see significant growth in that segment. Note, too, that in 1983 hardware vendors and applications-software developers will evenly share 80 percent of the sales of Unix applications packages. Systems integrators will represent a scant 4 percent. By 1986, however, that segment will be selling microcomputers





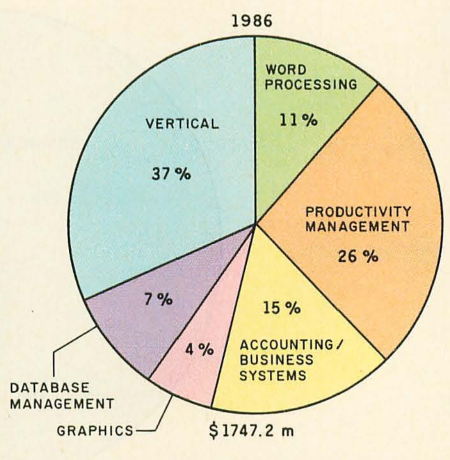
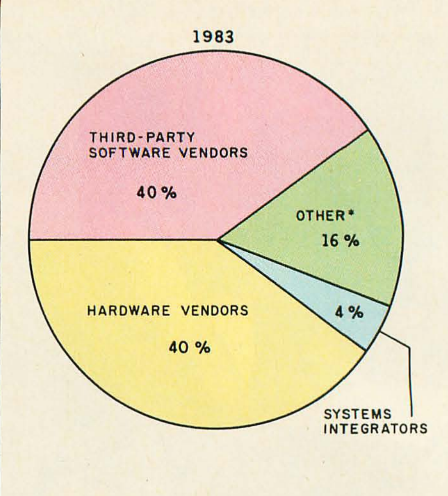
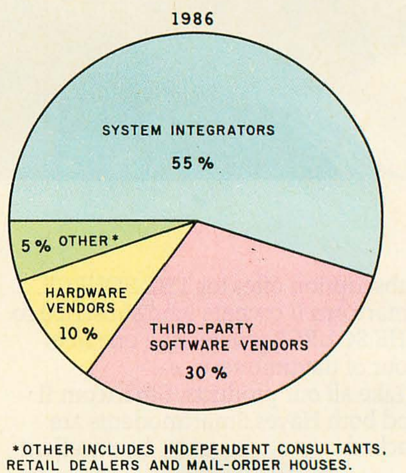


Figure 5: *Applications software for Unix 16-bit systems will bring in more than $1.7 billion in 1986.*







*OTHER INCLUDES INDEPENDENT CONSULTANTS, RETAIL DEALERS AND MAIL-ORDER HOUSES.

Figure 6: *Turnkey systems for vertical markets will strengthen systems integrators' position among vendors of Unix applications software.*

with Unix as the standard operating system, and its turnkey system for vertical markets will bring its market share to 55 percent. Also by that time, independent third-party vendors of applications software will control 30 percent of the market while hardware vendors hold on to 10 percent.

Conclusion

The standardization of small computer systems, which began at the hardware level, has now reached operating systems and applications software aimed at the Unix market. Encouraged by the availability of Unix on microcomputers, minis, and mainframes, vendors will continue to adapt it across the spectrum of microcomputer and mainframe products. Moreover, the vertical market for Unix will expand. In the future, Unix microcomputers can be expected to command a large share of the microcomputer market because they are priced higher than units that run MS-DOS and CP/M. In the years ahead, those Unix-based micros will be sold largely by systems integrators that will offer vertical-market turnkey systems previously offered only on minicomputers with proprietary operating systems. ■

Jean L. Yates is president of Yates Ventures (4962 El Camino Real, Los Altos, CA 94022), a firm that conducts marketing research on Unix, publishes periodicals and books, and produces training materials on the operating system's use. Author of The User Guide to the UNIX System *and* Business Guide to the UNIX System, *she is also a member of the National Computer Conference program committee.*



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A Tour Through the Unix File System

How to find your way around in the multiuser Unix operating system and its associated files

by James Joyce

Unix, a large operating system designed for multiple users, gives rise to many system and user files that can be segregated into different file areas, each with its own directory. This is preferable to having hundreds of files lumped into one work area because a simple request for a directory listing would fill a terminal's screen several times over. The Unix operating system, therefore, has a hierarchical, or tree-like, file system (though the tree is upside down, with the root at the top), allowing directories to contain subdirectories. Some users find themselves at a loss to understand the tangle this seems to present. Let's take a tour of the file system and pause at points of interest to see the sights.

The first point of interest is where we get on the tour by logging into a Unix system. I'll use my company's system in these examples:

```
ITS UNIX Welcomes You. Please,

:login: guest
Password:

  Step right this way for the tour!

%
```

The login procedure is standard on multiuser systems, with the system identifying itself and asking for user's name and password, then giving the message of the day once you successfully log on. The % is the Unix command interpreter's prompt character, letting you know it awaits your next command. Unix users will recognize the prompt as that of the C-shell developed by Bill Joy at the University of California at Berkeley. I will present examples in terms of the C-shell because it and other Berkeley enhancements to Unix are in widespread use throughout the Unix community and because all examples will be typescripts of an actual tour through the file system on my company's computer. Everything I type in and the system's responses have been captured by the script program developed by Mark Horton while he was also at Berkeley.

To tell where we are in the file system, the pwd command will print the working directory; that is, the directory where we are currently working within the Unix file system. In Unix, a *directory* is a file containing information about other files that are said to be "inside" it.

```
% pwd
/usr/guest
%
```

The result of pwd is the full *path name* to the working directory, showing which directories you go through to get to the present directory. The first slash (/) indicates root, the top of the file system hierarchy. The root file contains usr (pronounced "user"—the directory of users), and the second slash separates the name usr from guest, our account name. The guest directory is inside the usr directory and contains all the files of the guest account. Figure 1 is a diagram of this relationship. Directory entries include *pointers* to files elsewhere on the disk, as the lines in the diagram suggest, rather than the actual files themselves.

What's Inside /usr/guest ?

The login directory /usr/guest contains several files whose names you can see by typing the ls command to list file names:

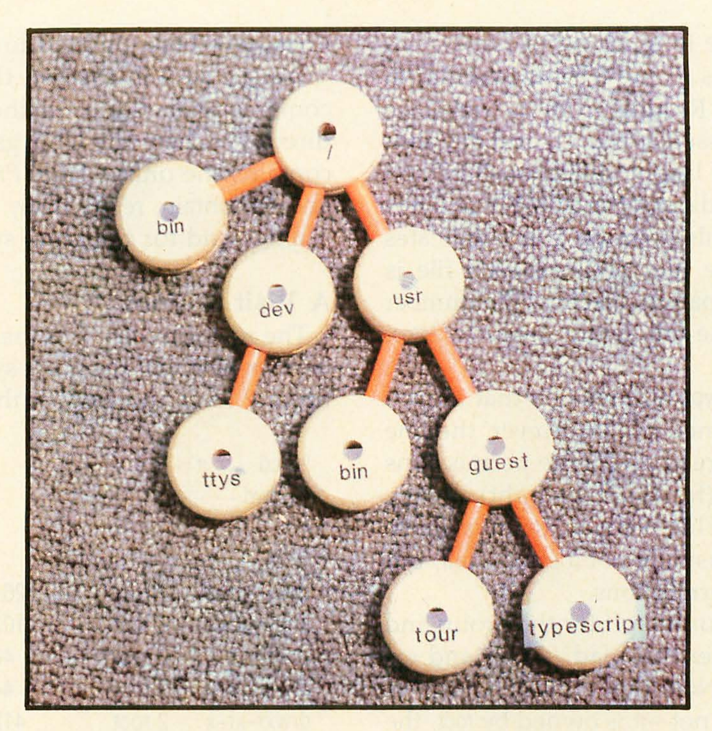


Figure 1: *The relationship of directories and files in the Unix hierarchical file system. (Photo by James Joyce.)*

```
% ls
tour
typescript
%
```

The file tour contains the text of this article, and typescript is the copy of what appears on my screen during the tour presented here.

The command ls -a produces a list of *all* files, even those that begin with a period or "dot" (.), which usually indicates special system file names.

```
% ls -a
.
..
.cshrc
tour
typescript
%
```

We see three new files, the names of which are pronounced "dot," "dot-dot," and "dot-c-s-h-r-c." The first filename, "dot," is a nickname for the current directory. (Perhaps an easy way to remember this is to think of the dot as the Unix shell, or command interpreter, pressing its finger against the inside of the screen to point to where it's currently working.) The listing of files gives the . and .. directories, too, which means directories also are files. The second file, "dot-dot," is short for the parent directory, one level up from where you are. Every directory has at least two entries in it, one for "dot" and one for "dot-dot," files that are automatically created whenever a directory is made using mkdir, the make-directory command.

The file .cshrc is used by the C-shell to tailor its actions to your desires. You can even customize the prompt to something else by typing

```
set prompt="Yes, Jim?"
```

so that instead of % you are prompted with

```
Yes, Jim?
```

There is much more that can be done with the .cshrc file, but we must press on with the tour.

Permissions, Owners, Sizes of Files

So far we are learning how to be tourists in the Unix file system. The pwd command tells us what directory we are in, and the ls command tells us what files are in that directory. Next we'll learn about permissions, ownership, the size of files, and date stamping. The command ls -la produces the *long* listing of *all* files:

```
% ls -la
drwxr-xr-x  2 guest     144 Jun 25 12:49 .
drwxr-xr-x 32 root      544 Jun 21 00:26 ..
-rwx------  1 guest      98 Dec 18 1982  .cshrc
-rw-rw-rw-  1 guest    1561 Jun 25 12:46 tour
----------  1 guest     176 Jun 25 12:50 typescript
%
```

The first character in each line is either a hyphen, indicating the file is an ordinary file, or a d, indicating the file is a directory. Not surprisingly, "dot" (our working directory) and "dot-dot" (our parent directory) have a

d in the first position of the long listing of files.

We can see the file names in the right-most column of the ls command's output. Reading from the right, we can see a date stamp, expressed as month and day (Jun 25 for typescript), and time of last modification (12:50 on a 24-hour clock). The 176 indicates the number of bytes in the file, and guest is the file's owner. The 1 indicates the number of links to the file. Because each file is minimally linked once to its parent directory, the number of links is at least one. If the link count drops to zero, the file is deleted.

The line of hyphens for typescript tells us that all *permissions* for the file are "turned off." However, the line of permissions for tour says read and write permissions (r and w) are enabled for (from left to right) owner, group, and everyone else. This file is actually writable by anyone on the system—usually not a good idea, but a demonstration here of permissions.

Permissions for .cshrc are turned off for the group and everyone else, but the owner can read, write, and execute (r, w, and x) the file. Note that although "dot" is owned by guest, "dot-dot" is not—it is owned by root, the parent of all Unix files.

Changing Directories

The cd command changes directories, and if you simply want to go up one level the command is

```
% cd ..
%
```

and, to verify that you have done so:

```
% pwd
/usr
%
```

Instead of /usr/guest the response from pwd is /usr, meaning that you have successfully moved up one level in the file system. The next thing to do is to see what files are at that level:

```
% ls -l
drwxr-xr-x   2 root     64 Jun 11 12:27  adm
drwxr-xr-x   2 check   400 Jun 22 14:22  bin
drwxr-xr-x   2 root    128 Jun 11 12:33  dict
drwxr-xr-x   3 root    336 Jun 11 12:38  games
drwxr-xr-x   2 guest   144 Jun 25 12:49  guest
drwxr-xr-x   4 root    448 Jun 11 12:46  include
drwxr-xr-x   9 jim     528 Jun 24 17:26  jim
drwxr-xr-x  13 root    496 Jun 13 15:41  lib
drwxr-xr-x  20 root    320 Jun 11 13:16  man
drwxr-xr-x   2 root     32 Jun 11 13:17  preserve
drwxr-xr-x   7 root    112 Jun 11 13:19  spool
drwxr-xr-x  14 root    320 May 30 15:06  src
drwxr-xr-x   2 root    112 Jun 11 13:20  sys
%
```

In this and following long listings of directories, some lines have been omitted to save space.

We see guest in the list, the directory we just left. It comes alphabetically in the list, just after games, the directory where the Unix games are. The man directory contains the online *Unix Programmer's Manual*, and src and sys contain, respectively, the source code for the user utilities and for the Unix system.

A Visit to Root

The root directory, /, is the parent of all directories, the *primum mobile* of the Unix system. And when we move up one level and look at the contents of root we see:

```
% cd ..
% pwd
/
% ls -l
drwxr-xr-x   2 root    2672 Apr  5 16:38  bin
drwxr-xr-x   2 root    1024 Jun  8 15:21  dev
drwxr-xr-x   2 root     480 Jun 11 23:01  etc
drwxr-xr-x   2 root     448 Jun  8 17:00  lib
drwxr-xr-x   2 root    4128 Oct  5 1982   lost+found
drwxrwxrwx   2 root      32 Oct  5 1982   mnt
drwxrwxrwx   5 root     464 Jun 25 12:48  tmp
-rwxr--r--   1 root   65206 Jun  8 12:09  unix
drwxr-xr-x  32 root     544 Jun 21 00:26  usr
%
```

The directory bin (pronounced as it is spelled) contains the executable binary versions of the Unix utilities, such as ls and pwd. Scanning down the list, the eye leaps to the file named unix. Unlike the other files, it is not a directory. It is an executable file, as the permissions indicate, but it is executable only by root, the owner. The file unix is the *kernel*, or the control program, of the Unix system. Unix is a term that can apply either to the kernel of the Unix system or to the totality and functionality of programs that run on the Unix system.

Let's tour some of the more interesting directories.

Touring /bin

First we will change our working directory into /bin and then find the number of files inside it.

```
% cd /bin
% ls | wc -l
  165
%
```

The second line in the example is a two-part command. First ls is run, and its output is sent (or *piped*) to the wc (word count) program, which is in turn told to report only the number of lines it counts. There are 165 commands in /bin. To see them we type

```
% ls -l
-rwx--x--x  1 bin   34964 Oct 5 1982   adb
-rwx--x--x  1 bin     307 Oct 5 1982   calendar
-rwx--x--x  1 bin    9216 Oct 5 1982   cat
```


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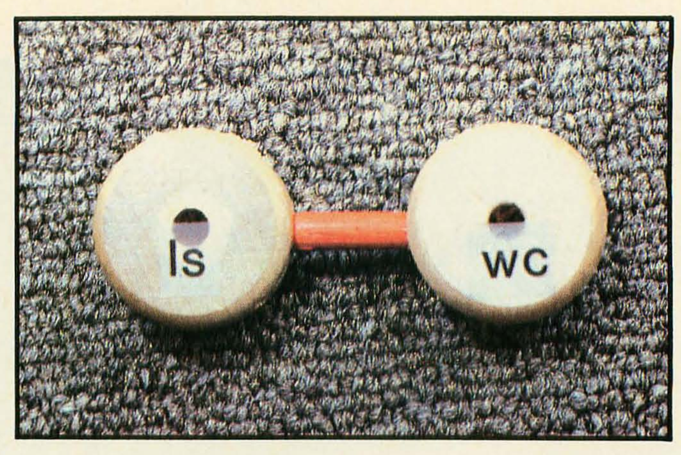


Figure 2: *An example of piping the output of one program through another program. (Photo by James Joyce.)*

```
-rwx--x--x 1 bin      12060 Oct 5 1982  cb
-rwx--x--x 1 bin      12892 Oct 5 1982  cc
-rwx--x--x 1 bin       8288 Oct 5 1982  chmod
-rwx--x--x 1 bin       9528 Oct 5 1982  cp
-rwx--x--x 1 bin      61212 Oct 5 1982  csh
-rwx--x--x 1 bin      10836 Oct 5 1982  date
-rwx--x--x 1 bin       2748 Oct 5 1982  echo
-rwx--x--x 1 bin      40244 Oct 5 1982  eqn
-rwx--x--x 1 bin      12508 Oct 5 1982  file
-rwx--x--x 1 bin      14324 Oct 5 1982  find
-rwxr-xr-x 1 bin        438 Oct 5 1982  lint
-rwx--x--x 1 bin      20564 Oct 5 1982  login
-rwx--x--x 1 bin      21148 Oct 5 1982  ls
-rws--x--x 1 root     23972 Oct 5 1982  mail
-rwx--x--x 1 bin      12112 Oct 5 1982  man
-rws--x--x 1 root      8636 Oct 5 1982  mkdir
-rwx--x--x 1 root     10236 Oct 5 1982  mv
-rwx--x--x 1 bin      57844 Oct 5 1982  nroff
-rws--x--x 1 root     16808 Oct 5 1982  passwd
-rwx--x--x 1 bin       8436 Oct 5 1982  pwd
-rwx--x--x 1 bin      10140 Oct 5 1982  rm
-rwx--x--x 1 bin      12564 Oct 5 1982  script
-rwx--x--x 1 bin      24900 Oct 5 1982  sh
-rwxr-xr-x 1 bin        546 Oct 5 1982  spell
-rwx--x--x 1 bin      42964 Oct 5 1982  tbl
-rwx--x--x 1 bin      62496 Oct 5 1982  troff
-rwx--x--t 4 bin     120456 Oct 5 1982  vi
-rwx--x--x 1 bin       8536 Oct 5 1982  wc
%
```

Some of the files, such as vi, the visual screen editor, seem astonishingly large, and others, such as spell, the program that checks spelling, seem astonishingly small. One explanation is that small files may be *shell scripts*, or files containing lines of shell commands that call on other programs to do parts of the desired task under the direction of the script.

Two entries in the long listing deserve brief mention. The vi entry has a t where execute permission for others is normally indicated. The t signifies that the "sticky bit" is set, so that vi stays around in the system's swap space, ready for execution. The s in the entry for mkdir indicates "set user identification code on execution," allowing the user access to otherwise restricted files.

The vast number of commands in bin and the pipe symbol (|) help applications developers join them like Tinkertoys to make new applications. A Tinkertoy-style example of piping the output of ls through wc can be seen in figure 2. Often, using shell scripts, developers can produce applications by using existing general-purpose programs. These applications may be slower than specific programs written from scratch, but developers will have something working quite a bit sooner.

Why /usr/bin ?

The /bin directory is quite large, and in part to keep it manageable (remember that command names are searched for sequentially), the overflow from /bin is put in /usr/bin. The /usr/bin directory is also the place for local program additions, although some installations create a directory called /local for that purpose. Let's see what is in /usr/bin.

```
% cd /usr/bin
% ls | wc -l
  22
% ls -l
-rwxr-xr-x 1 root     17020 Oct 27 1982  cu
-rwxr-xr-x 1 root     15652 Oct 27 1982  put
-rwxr-xr-x 1 root     21764 Oct 27 1982  take
-rwxr-xr-x 1 root     31060 Oct  5 1982  uucp
-rwxr-xr-x 1 root     18204 Oct  5 1982  uulog
-rwxr-xr-x 1 root      8712 Oct  5 1982  uuname
-rwxr-xr-x 1 root     28708 Oct  5 1982  uux
%
```

The first three files are parts of the cu, or call Unix, program that allows a user of one Unix system to call up another computer system over a telephone line and either execute commands on that system as though logged in as a normal user or communicate between the two machines to put a file to that system or take a copy

of a file from that system. The other files are parts of the Unix-to-Unix copy program, an improved facility similar to cu. These communications capabilities come with the standard Unix system.

Relative Pathnames and /usr/lib

Because every directory's parent has the nickname "dot-dot," we can change into a directory at the same level (that is, attached to the same parent directory) as our present directory by using .. in the cd command.

```
% cd ../lib
%
```

We are now in /usr/lib and can see how many files there are and what they are by using the commands we've learned.

```
% ls | wc -l
  29
% ls -l
-rw-r--r--   1 root       57 Mar 17 23:27  crontab
drwxr-xr-x   2 root      432 Jun 11 12:53  font
drwxr-xr-x   2 root       64 Jun 11 12:49  lex
drwxr-xr-x   2 root       64 Jun 11 12:49  macros
-rwx--x--x   1 root    14876 Oct 27 1982   spell
drwxr-xr-x   2 root      192 Jun 11 12:51  tmac
drwxr-xr-x   3 root      496 Jun 11 12:52  uucp
%
```

The files are restricted in that they are readable by others or executable by others but not writable by others. Just as with library books from your local public library, you are not to write in the holdings in this electronic library.

Some of the directories here are specific libraries for the named programs. For example, lex is a library for the lex program in /bin, and uucp is a library for the uucp programs in /usr/bin. But what is the directory called font? We can go look with the command

```
% cd font
%
```

Typing the commands to tell us how many files are in a directory and what they are is becoming a bit tiresome, and so it is time to introduce the history mechanism of the C-shell.

Historical Commands

To see the most recent commands we have given the C-shell, we enter

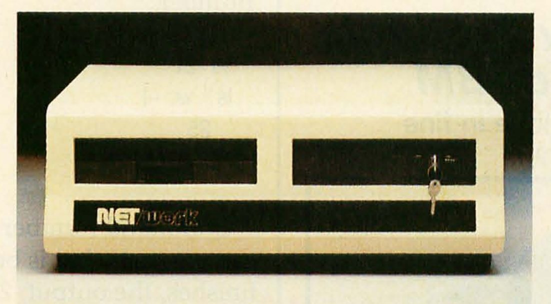
```
% history
  21 ls | wc -l
  22 ls -l
  23 cd font
  24 history
%
```

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Winchester formatted Mbytes (min/max)	16/102	10/20	15/30	20/40
Total RAM per user	128K	48K	64K	64K
User TPA	63.5K	48K	54K	62K
8- and/or 16-bit user processors	YES	NO	YES	NO
Perfect Software[1]	YES	NO	NO	NO
Telecommunications Software	YES	NO	NO	NO
Operating system[1]	Turbo-DOS	MP/MII	Mmm-OST	M/NET
Use with any terminal	YES	YES	NO	YES
Price (2 user system)	$7,495[2]	$7,490	$10,785[3]	$13,400



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The lines numbered 21 through 24 show the last four commands, indicating that they are the 21st through 24th commands typed so far. To execute a previous command, type the exclamation point (!) followed by the command number.

```
% !21
ls | wc -l
  25
%
```

Command number 21 is shown on the screen so you can see just what is being executed. After the command finishes, the output, 25, appears to let us know there are 25 files in the directory /usr/lib/font. Here are a few of them:

```
% !22
ls -l
-rw-r--r-- 1 root        256 Oct 27 1982  ftB
-rw-r--r-- 1 root        256 Oct 27 1982  ftI
-rw-r--r-- 1 root        256 Oct 27 1982  ftR
%
```

Again, a number of lines have been deleted in the interest of brevity. Those who know troff (the Unix typesetting utility) codes for the phototypesetter will recognize these names as the principal fonts—boldface, italic, and roman, respectively.

You Can Go Home Again

This tour has taken us far and wide in the file system, and even the most ardent Unix fan must admit to having gotten lost one time or another. Of course, we can always find out where we are by using the pwd command.

```
% pwd
/usr/lib/font
%
```

But how do we get back home, to our login directory? (In Unix terminology, the log-in directory is the home directory.) The cd command has a most pleasant default—if you do not type a file name, it defaults to your home directory.

```
% cd
% pwd
/usr/guest
%
```

So no matter how much you explore Unix, no matter how lost you may feel, and no matter how deep in directories you may be, you can return to your home directory by typing cd and pressing Return.

Unix offers many alternatives, and in fact there is another way to go home—through use of the tilde (~) notation:

```
% cd ~guest
% pwd
/usr/guest
%
```

The tilde notation is not restricted to your home directory but can be used with any valid login name.

```
% cd ~jim
% pwd
/usr/jim
%
```

You can specify a directory within a login directory if you know its name.

```
% cd ~jim/letters
% pwd
/usr/jim/letters
%
```

The Unix System's Closet

We are nearing the close of our tour of the Unix file system, but we could not leave without looking into the Unix system's closet, /etc.

```
% cd /etc
% ls | wc -l
  28
% ls -l
-rwx------ 1 bin    7736 Apr  5 16:18 cron
-rw-r--r-- 1 root    106 Jun  8 16:55 group
-rw-r--r-- 1 bin      32 Jun  8 16:54 ident
-rwx------ 1 bin    6248 Apr  5 16:18 init
-rw-r--r-- 1 bin      32 Jun 23 10:23 motd
-rw-r--r-- 1 root   2467 Jun 21 00:26 passwd
-rw-r--r-- 1 bin     321 Jun 21 15:43 rc
-rw-r--r-- 1 bin   42020 Apr  5 16:18 termcap
-rw-r--r-- 1 root     31 Jun 23 13:33 ttys
-rw-r--r-- 1 bin      49 Jun 23 13:39 ttytype
%
```

Many people may already know that the online password file is /etc/passwd. Some may have heard of termcap, the file that describes terminal capabilities to such programs as the vi screen editor, the rogue game (similar to Dungeons and Dragons), and application programs doing screen-oriented updating using the curses package. But few will have heard of the other files here. They are employed by the system rather than by users, although users definitely benefit from them.

The ident file contains the greeting that identifies the system to a potential user. The contents of this file can be displayed by typing cat, the Unix command commonly used to display a file.

```
% cat ident
ITS UNIX Welcomes You. Please,
%
```



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The motd file contains the message of the day, displayed as each user logs into the system.

```
% cat motd
  Step right this way for the tour!
%
```

The ttys file tells whether a given terminal on the system is allowed to display a login message, and what data rate the terminal connected to it must be. The ttytype file tells the type of terminal that is connected to the system, so the routines that use termcap can look up the characteristics of a particular terminal and take advantage of its capabilities.

The End of This Tour

We now come to the end of this brief tour of the Unix file system. The tour did not last long, but it did range fairly widely over the file system. It should be apparent that the file system is highly organized, although, as the *Unix Programmer's Manual* indicates, the position of files is subject to change without notice. The warning is not given without reason.

Unix is disk-intensive, simply because there are so many files in so many directories. A typical Unix system takes 10 megabytes of disk storage to allow for several users. If the commands and user files are on the same disk, that disk often cannot keep up with the processor's demands for data. Some Unix systems achieve noticeable improvements in performance simply by putting the /usr files on a separate disk from /bin. Many other improvements of a similar nature are quite straightforward; someone who has read this article carefully could anticipate them.

Those of you who have Unix available to you are encouraged to take this tour on line, with the article near your terminal, taking notes of the differences. Drawing a diagram of your system will show you much I have not had time to discuss here.

To leave the tour properly, we should return home:

```
% cd
% pwd
/usr/guest
%
```

and, finally, exit the Unix system with a Control-D or, in the case of my system,

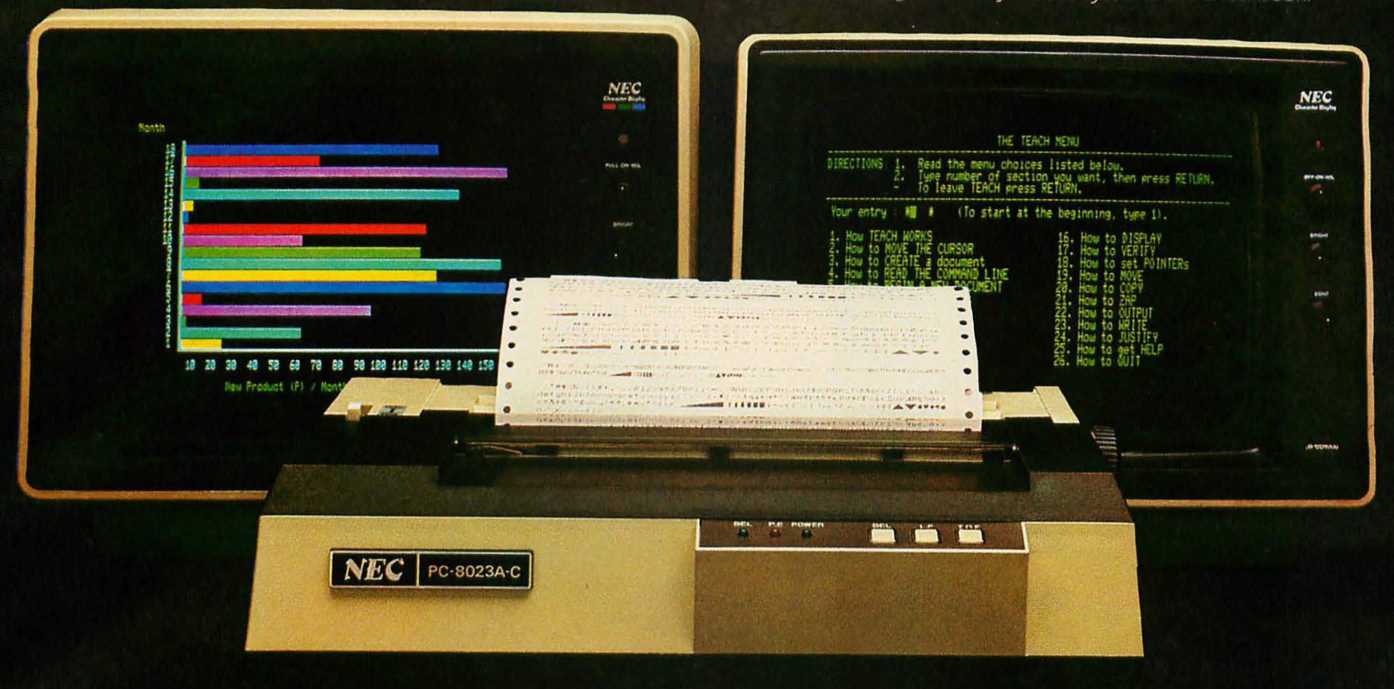
```
% logout
```

■

James Joyce is president of International Technical Seminars, a Unix consulting firm, and founder of the Independent Unix Bookstore (520 Waller Street, San Francisco, CA 94117).

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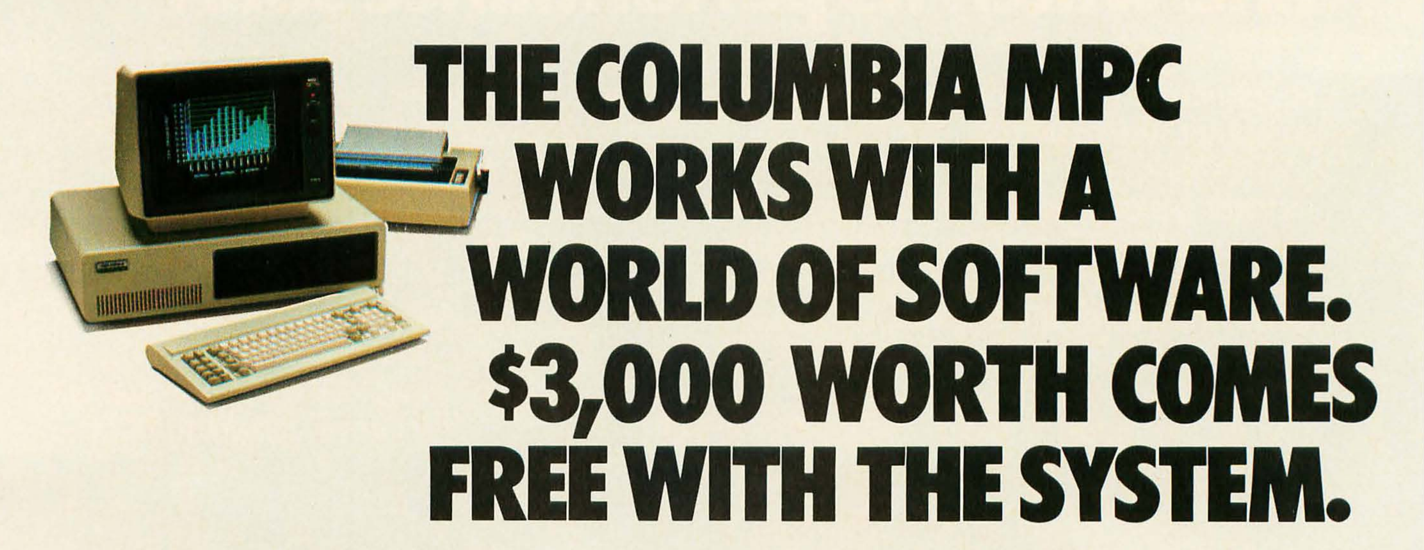
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The Unix Shell

The Unix shell is both an interactive command interpreter and a programming language

by Stephen R. Bourne

The Unix shell is both a programming language and a command language. As a command language it provides a user interface to the process- and file-handling facilities of the Unix operating system. As a programming language it contains mechanisms found in algorithmic languages. This combination encourages use of important concepts unique among operating systems. The shell can modify the environment in which commands are executed; the outcome of a command may determine the flow of control. The flow of data may also be controlled and redirected via the shell, enabling communication between processes.

The shell executes commands that are read from either a terminal or a file. Simple commands are written as sequences of "words" separated by blanks. The first word is the name of the command to be executed; remaining words are passed as arguments to the command invoked. For example, the command

```
ls -l
```

prints a *list* of the filenames in the current directory. The argument -l tells ls to print the date of last use, the size, and the status of each file.

Commands are similar to procedure calls in languages like Pascal or FORTRAN. The notation is different in two respects. First, although the arguments are arbitrary strings, they need not be enclosed in quotes in most cases. Second, there are neither parentheses enclosing the list of arguments nor commas separating them. Command languages tend not to have the extensive expression syntax found in algorithmic languages. Their primary purpose is to issue commands; it is therefore important that the notation be free from superfluous characters.

To execute a command, the shell creates a new process and waits for it to finish. These operations are primitives available in the Unix operating system. A command may be run without waiting for it to finish using the postfix operator &. For example,

```
print file &
```

calls the print command with the argument file and executes it in the background. The & is a metacharacter (i.e., has special meaning to the shell) interpreted by the shell and is not passed as an argument to print.

Associated with each process is a set of file descriptors numbered 0,1, . . . , used in all I/O (input/output) transactions between processes and the operating system. File descriptor 0 is termed the standard input, and file descriptor 1 is termed the standard output. Most commands produce their output on the standard output that is initially (after logging in) connected to a terminal. This output may be redirected for the duration of a command, as in

```
ls -l > file
```

The notation >file is interpreted by the shell and is not passed as an argument to ls. If the file does not exist, it is created; otherwise, the contents of the file are replaced with the output from the command.

To append to a file, the notation >>file is provided, as in

```
ls -l >> file
```

The standard input may be taken from a file by writing, for example,

```
wc < file
```

Wc (word count) prints the number of characters, words, and lines on the standard input.

The standard output of one command may be connected to the standard input of another by writing the "pipe" operator, indicated by |, as in

```
ls -l | wc
```

Two commands connected in this way constitute a "pipeline," and the overall effect is the same as

```
ls -l > file
wc < file
```

except that no file is used. Instead, the two processes are connected by a pipe created by an operating system call. Pipes are unidirectional; synchronization is achieved by halting wc when there is nothing to read and halting ls when the pipe is full. The Unix operating system, not the shell, deals with this matter.

A *filter* is a command that reads input, transforms it in some way, and prints the result as output. One such filter, grep (to search a file for a pat-

tern), selects from its input those lines that contain some specified string. For example,

```
ls | grep old
```

prints those filenames from the current directory that contain the string old.

A pipeline may consist of more than two commands; the input of each is connected to the output of its predecessor. For example,

```
ls | grep old | wc -l
```

prints the number of files in the current directory with names containing the string old.

Filename Generation

Many commands accept arguments that are filenames. For example,

```
ls -l main.c
```

prints information relating to the file main.c. The shell provides a mechanism for generating a list of filenames that match a pattern. For example,

```
ls -l *.c
```

generates, as arguments, to ls all filenames in the current directory that end in .c. The character * is a pattern that matches any string including the null string. In general, shell patterns are specified using the following notation: * matches any string of characters including the null string; ? matches any single character; [. . .] matches any of the individual characters enclosed. A pair of characters separated by a minus matches any character lexically between the pair.

For example,

```
[a-z]*
```

matches all names in the current directory beginning with one letter from a through z.

```
/usr/fred/epns/?*
```

matches all names in the directory /usr/fred/epns that consist of at least one character. If no filename matches the pattern, the pattern is passed, unchanged, as an argument. This mechanism is useful both to save typing and to select names according to some pattern. It may also be used for finding files. For example,

```
echo /usr/fred/*/core
```

finds and prints the names of all core files in first-level directories of /usr/fred. (Echo is a standard command that prints its arguments, separated by spaces.) This feature can be expensive, requiring a scan of all subdirectories of /usr/fred.

There is one exception to the rules given for patterns. The character . (period) at the start of a filename must be explicitly matched.

```
echo *
```

therefore echoes all filenames that don't begin with . in the current directory.

```
echo .*
```

echoes all filenames that begin with . in the current directory. This prevents inadvertent matching of the names . ("current directory") and .. ("parent directory"). (Ls suppresses information for . and . . .)

Care should be taken when you use the rm command with generated patterns. You could easily remove more files than you intend. To reduce the chance of error, first echo the pattern, as shown in this example:

```
echo tmp*
```

followed by

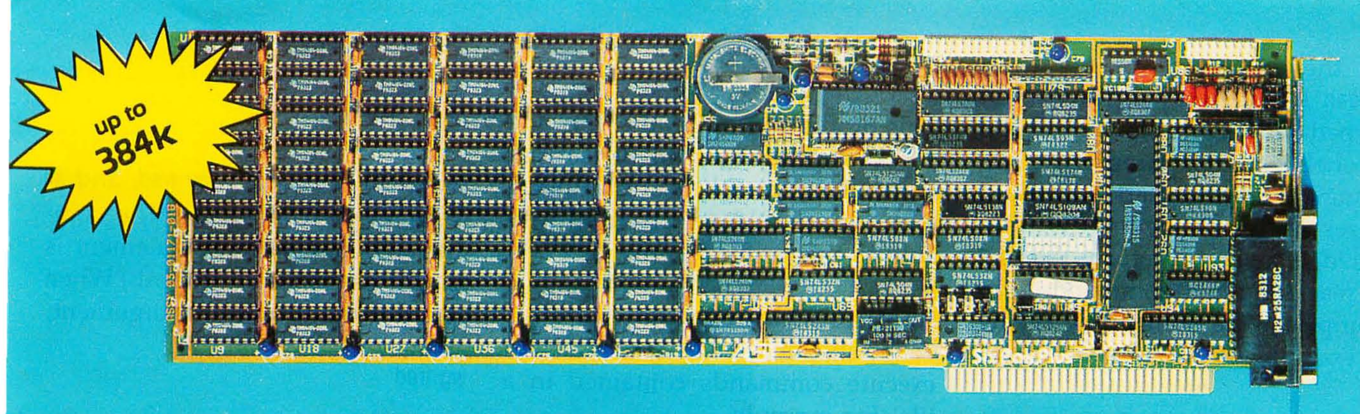
```
rm tmp*
```

Be careful not to introduce a space between tmp and *.

Interactive Use of the Shell

When the shell is used from a terminal, it issues a prompt before reading a command. By default this prompt is $. It may be changed by setting the prompt string:

```
PS1=yesdear
```



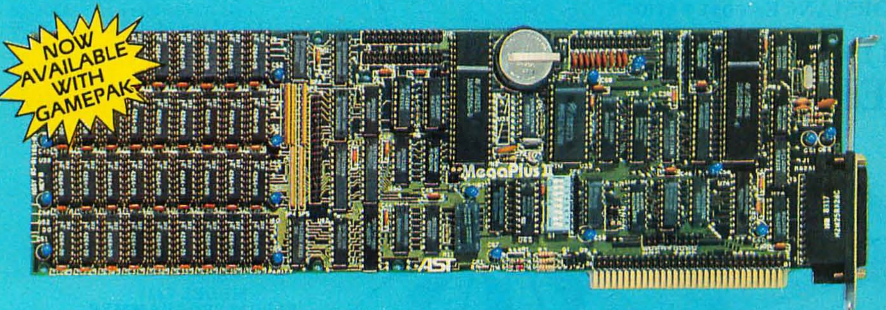
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sets the prompt to be the string yesdear. If a *newline* (carriage return) is typed and further input is needed, the shell issues the prompt >. Mistyping a quotation mark sometimes causes this. If the prompt is unexpected, an interrupt returns the shell to read another command. This prompt may be changed by saying, for example,

```
PS2=more
```

Following login, the shell reads and executes commands typed at the terminal. If your home directory contains a file named .profile, the shell executes it before reading any commands from the terminal. The following .profile is typical:

```
date
calendar
MAIL=/usr/spool/mail/srb
HOME=/usr/srb
PATH=.:./bin:/bin:/usr/bin:$HOME/bin
TERM=...
export MAIL HOME PATH TERM
```

This profile also prints the date and checks the calendar reminder service. If you always use the same terminal, then you should set the TERM variable in the profile.

Shell Procedures

The shell may be used to read and execute commands contained in a file. For example,

sh file arg_1 arg_2 . . .

calls the shell (itself a program, called sh) to read commands from file. Such a file is called a "shell procedure." Arguments supplied with the call are referred to within the procedure using the positional parameters $1,$2,. . . . If the file wg contains

```
who | grep $1
```

then

```
sh wg fred
```

is equivalent to

```
who | grep fred
```

where $1 is replaced by fred, and sh is an append command. (The command to end the case statement is esac, "case" spelled backward.) When append is called with one argument, as in

```
wg fred
```

is equivalent to

```
sh wg fred
```

This enables shell procedures and programs to be used interchangeably.

Frequently, procedures are used to loop through the arguments ($1, $2,. . .), executing commands once for each argument. An example of such a procedure is tel, which searches the file /usr/lib/telnos containing lines of the form

```
fred 277-0123
bert 277-0789
```

The text of tel is

```
for i
do grep $i </usr/lib/telnos; done
```

The default in list for a for loop is the positional parameters. The command

```
tel fred bert
```

prints those lines in /usr/lib/telnos that contain the string fred, followed by those lines that contain bert.

You can use procedures to tailor the command environment to your needs. Because procedures are text files requiring no compilation, they are easy to create and maintain. The capability to try out parts of a procedure at a terminal helps in debugging. To further assist debugging, the shell provides two tracing mechanisms. If a procedure is invoked with the -v flag, as in

```
sh -v proc
```

the lines of proc are printed as they are read. This is useful when checking procedures for syntactic errors, particularly in conjunction with the -n flag, which suppresses command execution. An execution trace is specified by the -x flag and causes each command to be printed as it is executed. When errors in the flow of control are suspected, the -x flag is more useful than -v.

During the execution of a procedure, the standard I/O is left unchanged, allowing procedures to be used as filters. However, commands sometimes require inline data. A special input redirection notation, <<, is used to achieve this effect. For example, the editor takes its commands from the standard input. At a terminal,

```
ed file
```

calls the editor and reads editing requests from the terminal. Within a procedure, this is written

```
ed file <<!
editing requests
!
```

The lines between <<! and ! are called a *here* document; they are read by the shell and made available as the standard input to the command being executed. The string ! is arbitrary; a line that consists of the string following << terminates the document. There are a number of advantages to making "here" documents explicitly visible. The number of lines read from the procedure is under the control of the procedure writer, enabling a procedure to be understood without having to know what commands such as ed do. Furthermore, because the shell is the first to see such input, parameter substitution can be optionally applied to the text of the document.

Control Flow

The case and for constructs provide for data-driven branching and looping. The for loop notation is recognized by the shell and has the general form

```
for name in w1 w2 . . .
do command-list
done
```

A *command list* is a sequence of one or more simple commands separated or terminated by a newline or ; (semicolon). Furthermore, reserved words like do and done are normally preceded by a newline or ;. A shell variable called *name* is set to the words *w1 w2* . . . in turn each time the command list following do is executed. If in *w1 w2* . . . is omitted, the loop is executed once for each positional parameter; that is, in $* is assumed.

Another example of the use of the for loop is the create command

```
for i do >$i; done
```

The command

```
create alpha beta
```

ensures that two empty files, alpha and beta, exist and are empty. The notation >file may be used on its own to create or to clear the contents of a file. Also note the ; (or newline) required before done. The notation <file may also be used to test for the existence of a file.

A multiple-way branch is provided by the case notation. For example,

```
case $# in
  1)  cat >>$1 ;;
  2)  cat >>$2 <$1 ;;
  *)  echo usage: append [ from ] to ;;
esac
```

is an append command. (The command to end the case statement is esac, "case" spelled backward.) When append is called with one argument, as in

```
append file
```

$# is the string 1 and the standard input is copied onto the end of file using the command cat >>$1.

```
append file1 file2
```

appends the contents of file1 onto file2. If the number of arguments supplied to append is other than 1 or 2, a message indicating proper usage is printed.

The general form of the case command is

```
case word in
  pattern) command-list ;;
  . . .
esac
```

each branch being terminated by ;;. The ;; preceding esac is optional.

The shell attempts to match *word* with each *pattern* in the order the patterns appear. If a match is found, the associated command list is executed, and execution of the case is complete. Because * is the pattern that matches any string, it can be used for the default case. Caution: no check is made to ensure that only one pattern matches the case word. The first match found defines the set of commands to be executed. Below, the commands following the second * will never be executed.

```
case $# in
  *) . . . ;;
  *) . . . ;;
esac
```

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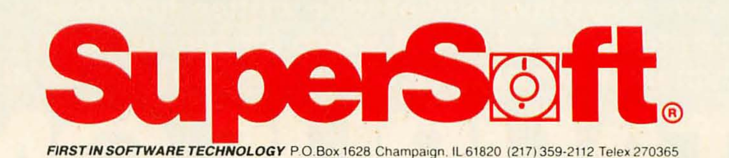
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The case construction can also be used to distinguish different forms of an argument. The following example is a fragment of a cc command.

```
for i
do   case $i in
       -[ocs]) . . . ;;
       - *)   echo unknown flag $i ;;
       *.c)   /lib/c0 $i . . . ;;
       *)     echo unexpected argument $i  ;;
     esac
done
```

To allow the same commands to be associated with more than one pattern, the case command provides for alternative patterns separated by a |. For example,

```
case $i in
   -x|-y) . . .
esac
```

is equivalent to

```
case $i in
   -[xy]) . . .
esac
```

The usual quoting conventions apply; thus

```
case $i in
   \?) . . .
esac
```

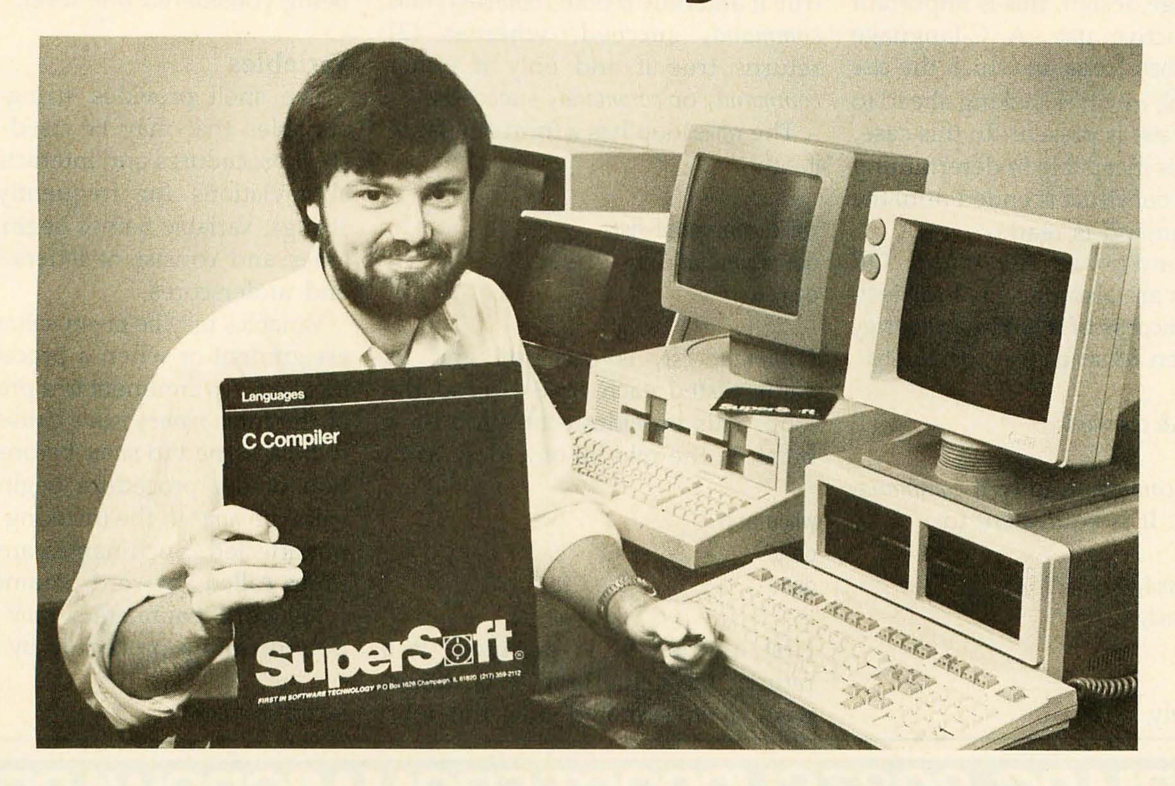
matches the character ?.

When a command finishes execution, it returns an *exit status* (return code). Conventionally, a zero exit status means the command succeeded; nonzero means it failed. This Boolean value can be tested using the if and while constructs. The general form of the conditional branch is

```
if   command-list
then command-list
else command-list
fi
```

The else part is optional. The value tested by if is that of the last simple command in the command list following if. Because this construction is bracketed by if and fi, it may

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be used unambiguously in any position that a simple command may be used. This is true of all the control-flow constructions. Furthermore, in the case of if there is no dangling else ambiguity. Apart from considerations of language design, this is important for interactive use. A C-language style if ... then ... else, in which the else is optional, involves looking ahead to see if the else is present. In this case, the shell is incapable of determining that the if construct is ended until the next command is read.

The conditional AND and OR operators are also provided for testing the success of a command; they are written && and ||, respectively.

$command_1$ && $command_2$ (1)

executes $command_2$ only if $command_1$ succeeds. It is equivalent to

```
if   command1
then command2
fi
```

Conversely,

$command_1$ || $command_2$ (2)

executes $command_2$ only if $command_1$ fails. The value returned by these constructions is the value of the last command executed. Thus (1) returns true if and only if both $command_1$ and $command_2$ succeed, whereas (2) returns true if and only if either $command_1$ or $command_2$ succeeds.

The while loop has a form similar to if.

```
while command-list1
do command-list2
done
```

Command-list$_1$ is executed and its value tested each time around the loop. This provides a notation for a break in the middle of a loop, as in

```
while a; b
do c
done
```

First a, then b, is executed. If b returns false, the loop exits; otherwise, c is executed and the loop resumes at a. This deals with many loop breaks, but break and continue are also available. Both take an optional integer argument specifying how many levels of loop to break from or at which level to continue, the default being considered one level.

Variables

The shell provides string-valued variables that may be used within shell procedures and interactively as abbreviations for frequently used strings. Variable names begin with a letter and consist of letters, digits, and underscores.

Variables may be given values by an assignment or when a procedure is invoked. An argument to a procedure of the form *name=value* causes *value* to be assigned to *name* before execution of the procedure begins. The value of *name* in the invoking shell is not affected. Such names are sometimes called keyword parameters.

Keyword parameters may be exported from a procedure by saying

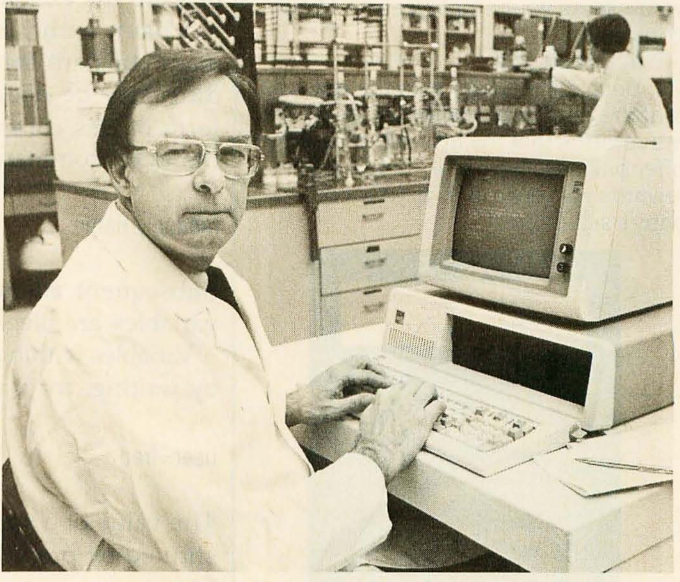
```
export user box
```

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Modification of such variables within the called procedure does not affect the values in the calling procedure. (Generally, a process may not modify the environment of its caller without an explicit request on the part of that caller. Files and shared file descriptors are the exceptions to this rule.)

A name with value intended to remain constant throughout a procedure may be declared readonly. The form of this command is similar to the export command,

```
readonly name . . .
```

Subsequent attempts to set readonly variables are illegal.

Variables within a procedure are set by writing, for example,

```
user=fred
```

The value of a variable may be substituted by preceding its name with $;

```
echo $user
```

echoes fred. (Echo is a standard command that prints its arguments, separated by blanks.) The general notation for parameter (or variable) substitution is

```
${name}
```

and is used, for example, when the parameter name is followed by a letter or a digit. If a parameter is not set, the null string is substituted for it. Alternatively, a default string may be given, as in

```
echo ${d-.}
```

which echoes the value of d if it is set, and . otherwise. Substitutions may be nested; thus

```
echo ${d-$1}
```

echoes the value of d if it is set; otherwise, it echoes the value (if any) of $1. A variable may be assigned a default value using the notation

```
${d=.}
```

which substitutes the same string as

```
${d-.}
```

unless d was not previously set, in which case it is set to the string . . (The notation ${. . .=. . .} is not available for positional parameters.)

When a parameter is required to be set, the notation

```
${d?message}
```

substitutes the value of the variable d if it has one; otherwise, message is printed, and execution of the procedure is abandoned. If message is absent, a standard message is printed. A procedure that requires some parameters to be set might start with

```
: ${user?} ${acct?} ${bin?}
. . .
```

The : command is built-in to the shell and does nothing after its arguments are evaluated. In this example, if any of the variables user, acct, or bin are not set, the shell abandons execution of the procedure. Some variables have a special meaning to the shell (see table 1).

Command Substitution

Standard output from a command can be substituted in a way similar to parameter substitution. The command pwd prints on its standard output the name of the current working directory. If the current directory is /usr/fred/bin, the command

```
d=`pwd`
```

is equivalent to

```
d=/usr/fred/bin
```

The entire string between grave accents (`. . .`) is taken as the command to be executed and is replaced with the output from the command. The command is written with the usual quoting conventions except a ` must be escaped using \. For example,

```
ls `echo "$1"`
```

is equivalent to

(a)

$?	The exit status (return code) of the last command executed as a decimal string. Most commands return a zero exit status if they complete successfully and return a nonzero exit status otherwise. Testing the value of return codes is deferred until the section on if and while commands.
$0	The name of the command procedure being executed. This variable can be used to distinguish cases when a command has more than one name. For example, the following script is called ttytek and a link to the same file exists called ttyblit. If the file has any other name, and is executed by that name, the default case applies. The command sets terminal options using the stty command `case $0 in` `ttyblit) stty erase ^H kill @ ff0 tabs ;;` `ttytek) stty erase ^H kill @ tek -tabs ;;` `*) stty erase ^H kill @ ;;` `esac`
$#	The number of positional parameters (in decimal); used, for example, in the append command to check the number of parameters. $# is also updated by the set command.
$$	The process number of this shell (in decimal). Because process numbers are unique among all existing processes, this string is frequently used to generate temporary filenames. For example, `ps a >/tmp/ps$$` `rm /tmp/ps$$`
$!	The process number of the last process run in the background (in decimal).
$-	The current shell flags, such as -x and -v.

(b)

$MAIL	When used interactively, the shell looks at the file specified by this variable before it issues a prompt. If the specified file has been modified since it was last looked at, the shell prints the message you have mail before prompting for the next command. For user fred, this variable is set as MAIL=/usr/spool/mail/fred
$HOME	The default argument for the cd command. The current directory is used to resolve filename references that do not begin with a / and is changed using the cd command. For example, cd /usr/fred/bin makes the current directory /usr/fred/bin. Cd with no argument is equivalent to cd $HOME
$CDPATH	The list of directories searched by cd. Each directory name is separated by : . A typical setting of this variable, CDPATH=:..:$HOME/desk specifies that cd should search the current directory, the parent directory, .. , and $HOME/desk. If the directory ../src exists, and there is no src directory in the current directory, cd src changes the directory to ../src and prints this string as confirmation.
$PATH	A list of directories that contain commands (the search path). Each time a command is executed by the shell, a list of directories is searched for an executable file. If $PATH is not set, the current directory, /bin, and /usr/bin are searched by default. $PATH consists of directory names separated by : . For example, PATH=.:./bin:$HOME/bin:/bin:/usr/bin specifies that the current directory (the . before the first :), ./bin, $HOME/bin, /bin, and /usr/bin are to be searched in that order. In this way, individual users can have their own commands in $HOME/bin accessible independently of the current directory. The directory ./bin allows access to any directory named bin from the current directory. This separates commands from data files within a directory associated with some project or activity. If the command name contains a /, the directory search is not used; a single attempt is made to execute the command. The form ./cmd may be used to bypass the search path for command in the current directory.
$PS1	The primary shell prompt string, by default, $.
$PS2	The shell prompts with $PS2 when more input is needed; by default, the value is >.
$IFS	The set of characters used for blank interpretation.

Table 1: *Variables that have special meaning to the shell. In table 1a, the variable* $? *is set after each execution of a command; all others are set initially by the shell. The variables in table 1b are typically set in the file* .profile *in the user's home directory.*

```
ls $1
```

Command substitution occurs in all contexts in which parameter substitution occurs (including "here" documents) and the resulting text is treated the same in both cases. This mechanism allows string processing commands to be used within shell procedures. An example of such a command is basename, which removes a specified suffix from a string. For example,

```
basename main.c .c
```

prints the string main. The following fragment from a cc command illustrates the use of basename.

```
case $A in
  ...
  *.c)    B=`basename $A .c`
  ...
esac
```

sets B to the part of $A with the suffix .c stripped. Here are some composite examples:

```
for i in `ls -t`; do ...
```

The variable is set to the names of files in time order, with the most recent files first.

```
set `date`; echo $6 $2 $3, $4
```

Print the date arguments in the order specified, e.g., 1970 Feb 3, 11:59:59. The output from date is Tue Feb 3 11:59:59 GMT 1970 and the shell breaks up this output as arguments for the set command. The result is assigned to the positional parameters.

```
a=`expr $a + 1`
```

Increment the shell variable a by 1 using the output from the expr command.

Evaluation and Quoting

The shell provides parameter substitution, command substitution, and filename generation for the arguments to commands. Let's look at the order in which substitutions occur and the effects of quoting mechanisms.

Before a command is executed, the following evaluations occur.

- parameter substitution, e.g., $user
- command substitution, e.g., 'pwd'

Substituted strings are not rescanned. For example, if the value of the variable X is the string $y, then

```
echo $X
```

echoes $y.

After these substitutions have occurred, the resulting characters are broken into words (blank interpretation); the null string is not regarded as a word unless it is quoted. For example,

```
echo ''
```

passes on the null string as the first argument to echo, whereas

```
echo $null
```

calls echo with no arguments if the variable null is not set or is set to the null string. Each word is then scanned for the file pattern characters *, ?, and [. . .], and an alphabetical list of filenames is generated to replace the word. Each such filename is a separate argument.

Metacharacters such as <, >, *, ?, |, and & have a special meaning. Any character preceded by a \ is quoted and loses its special meaning, if any. The \ is ignored; thus

```
echo \?\\
```

echoes ?\. To allow long strings to continue beyond one line, the sequence *newline* is ignored.

A \ is convenient for quoting single characters. When more than one character needs quoting, the above mechanism is clumsy and error prone. A string of characters may be quoted by enclosing part of the string between single quotes, as in

```
echo '*'
```

The quoted string may not contain a single quote.

A third quoting mechanism uses double quotes and prevents interpretation of some, but not all, metacharacters. Within double quotes, parameter substitution and command substitution occur, but filename generation and the interpretation of blanks do not. The characters in table 2 have a special meaning within double quotes and may be quoted using \. For example,

```
echo "$x"
```

passes the value of the variable x to echo, whereas

```
echo '$x'
```

passes the string $x to echo.

In cases requiring more than one evaluation of a string, the built-in command eval may be used. The eval command reads its arguments (which have therefore been evaluated once) and executes the resulting command(s). If the variable X has the value $y, and if y has the value pqr,

then

```
eval echo $X
```

echoes the string pqr.

Errors and Faults

The treatment of errors depends on the type of error and on whether the shell is being used interactively. An interactive shell is one with I/O connected to a terminal. Execution of a command may fail for any of the following reasons:

- I/O redirection fails because a file does not exist or cannot be created; in this case, the command is not executed
- the command itself does not exist or is not executable
- the command terminates abnormally; for example, with a "memory fault"
- the command terminates normally but returns a nonzero exit status

In all of these cases, the shell goes on to execute the next command. Except for the last case, an error message is printed.

$	parameter substitution
`	command substitution
"	ends the quoted string
\	quotes the special characters $, `, ", \

Table 2: *These characters have special meaning when enclosed in double quotes; they should be quoted using \.*

All remaining errors cause an exit from a procedure. An interactive shell returns to read another command from the terminal. Such errors include

- syntax errors; e.g., if . . . then . . . done
- a signal such as terminal interrupt; the shell waits for the current command, if any, to finish execution and then either exits or returns to the terminal
- failure of any of the built-in commands, such as cd

If any error is detected, the flag -e causes the shell to terminate.

Procedures normally terminate when an interrupt is received from the terminal. An interrupt is communicated to a process as a signal. If cleaning up (e.g., removing temporary files) is required, the built-in command trap is used.

```
trap 'rm /tmp/ps$$; exit' 2
```

sets a trap for terminal interrupt (signal 2) and, if this interrupt is received, executes the commands

```
rm /tmp/ps$$; exit
```

Another built-in command is exit, which terminates a procedure. The exit is required in the preceding example; otherwise, after the trap is taken, execution resumes at the place where interrupted.

Signals can be handled by a process in one of three ways. They can be ignored, in which case the signal is never sent to the process; they can be caught, in which case the process must decide what to do; or they can

be left to terminate the process. If a signal is ignored on entry to the procedure by invoking the procedure in the background, trap commands (and the signal) are ignored.

A procedure itself may elect to ignore signals by specifying the null string as the argument to trap. A trap may be reset by saying, for example,

```
trap 2
```

which resets the trap for signal 2 to its default value (exit).

The procedure scan exemplifies the use of trap without an exit in the trap command. The scan command takes each directory in the current directory, prompts with its name, then executes the command typed at the terminal. Interrupts are ignored while executing the requested commands but cause termination when scan is waiting for input.

```
d=`pwd`
for i in *
do  if test -d $d/$i
    then cd $d/$i
         while echo "$i:"
              trap exit 2
              read x
         do trap : 2; eval $x; done
    fi
done
```

The command

```
read x
```

is built-in to the shell and reads the next line from the standard input and assigns it to the variable x. The command

```
test -d arg
```

returns *true* if arg is a directory and *false* otherwise.

To execute a command, a new process is created using the system call fork. The execution environment for the command includes I/O and the states of signals. The environment is established in the created process before the command is executed. The built-in command exec is used in the rare cases requiring no fork.

The environment for a command run in the background, such as

```
list *.c | lpr &
```

is modified in two ways. First, the default standard input for this kind of a command is the empty file /dev/null. This prevents two parallel processes, the shell and the command, from trying to read the same input. Chaos would otherwise ensue.

```
ed file &
```

allows both the editor and the shell to read from the same input at the same time. The other means of modifying the environment of a background command is to turn off the *quit* and *interrupt* signals so they are ignored by the command, thus enabling use of these signals at the terminal without causing background commands to terminate.

Summary

You should now be able to begin using the Unix shell as a programming language to write your own shell scripts. Existing Unix commands can be easily combined to create your own tools. Some of the examples shown in this article are extremely useful. I recommend that avid Unix users go on to greater proficiency with the Unix shell.

The major alternative to the standard Unix "Bourne" shell is the C-shell developed at the University of California at Berkeley. The C-shell is superior for interactive use with its aliasing, history, and job-control facilities. But if you want to write portable shell scripts that can be used on any Unix system, use of the standard Unix shell is recommended because it is available on all Unix systems.■

Dr. Stephen Bourne is best known for his contributions to the Unix system, including the "Bourne" shell and the book The Unix System. *An internationally known computer scientist with 15 years of computer systems experience, he is one of the designers of the Cambridge Capability Computer and is recognized for his contributions to programming-language design and compiler-construction techniques. Dr. Bourne can be reached at Silicon Graphics Inc., 630 Clyde Court, Mountain View, CA 94043.*

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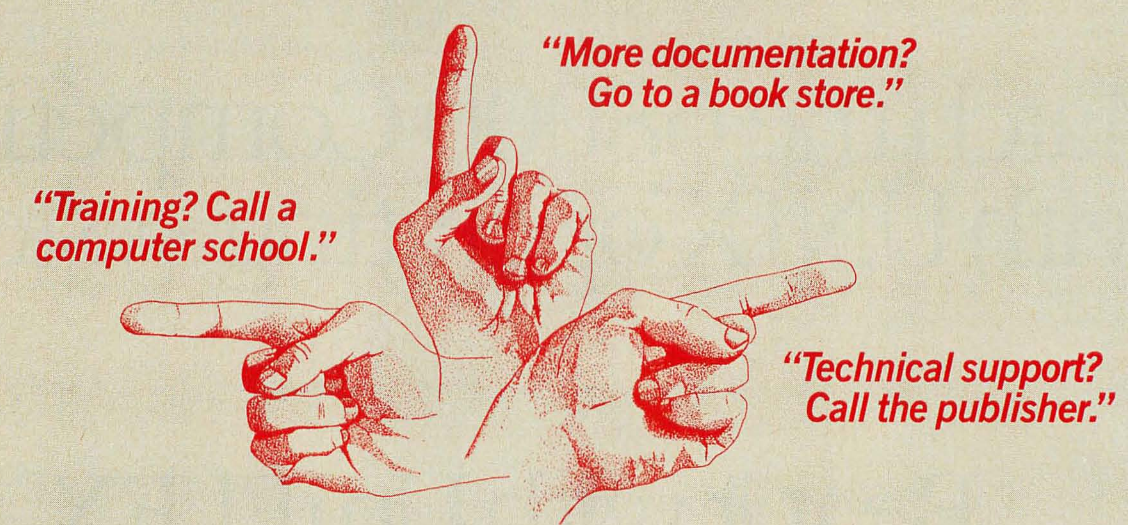
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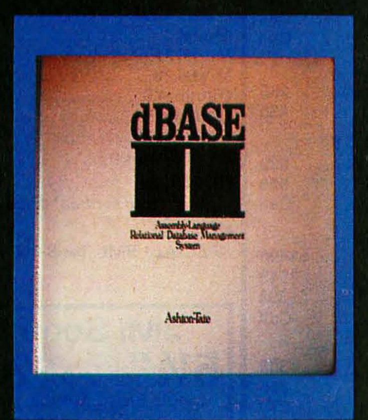


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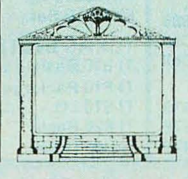
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Unix as an Application Environment

A tools approach to the needs of the business community

by Mark Krieger and Fred Pack

The operating system defines a computer's environment. And the first requirement of an environment is that it be reliable. Users need a robust software foundation—one that's not susceptible to a crash yet is able to exit gracefully when necessary. The system's stability should quell the need for releases of new applications, and the sponsoring organization should provide reliable support. Generally speaking, the operating system should be mature.

Users also have secondary needs. The operating system must provide a framework for its two kinds of users: the developers and the end users. Developers are most productive when they have good tools to aid the programming process. These tools include languages, debugging aids, text editors, and other utilities. End users have an entirely different set of needs. They should be isolated from the esoterica of the computer and be given something that is easy to use.

Finally, various technical features are needed:

- the ability to handle multiple users
- interprocess communication and concurrent operations so that users and their tasks can work together
- communication capability so that users on different machines can work together
- file locking so that users do not get in each others' way
- a rich set of utilities so that we are spared from having to create our own routines
- portability so that the programs we write today will continue functioning in the advanced machines available in the future
- a large body of applications so that the computer can immediately perform useful work for us

Because it meets these criteria, we believe that the Unix operating system is one of the systems of choice.

General Software Problems

Unfortunately, most designers of operating systems neglect the needs of the end user. The early designers didn't expect their systems to be used in the mass market, and later designers patterned their products after the originals to provide compatibility. Furthermore, most computer users were technically adept; system software "hand holding" wasn't necessary. Finally, until quite recently microcomputers' limited computational power kept designers from devoting the machine resources required to make the system software easy to use.

These historical problems are being overcome due to the dramatic drop in microcomputer prices and the increase in computer capabilities. Stated simply, a low-cost computer must not require extensive operator training. The typical computer user is someone with a problem to solve, not a computer professional.

The increased computer "horsepower," storage, and graphics capabilities that are standard today permit the system designer to make the system infinitely more pleasant to use for both computer professionals and the problem solver.

The historical problems of operating systems center on their tendency to be cryptic, unfriendly, and unstandardized. Phrasing a command precisely can require extensive study of a dense, technically oriented, and usually poorly worded system manual. Occasionally, machines respond even to proper commands with system-error-messages such as BDOS ERROR or ERR ON DEV 0/1, which are incomprehensible. The user may find that his data is lost because he forgot to issue the SYNC command when he turned off the

machine.

Integrated software application packages such as 1-2-3 from Lotus Development and Visi On from Visicorp provide session guidance, common data and command structures, and consistent documentation. However, a fully integrated environment can be achieved only by the underlying operating system. Apple's Lisa is the first of such systems. Lisa provides extensive graphical representation, lets users issue commands without keying, and can exchange data with all the integrated applications.

Alternatives

Several operating systems are vying for a significant share of the microcomputer marketplace. The primary ones are CP/M, MS-DOS, Pick, and Unix. Lisa-style operating systems will soon be contenders.

CP/M: CP/M was the first significant microcomputer operating system. Consequently, it has the largest collection of application software. Because the older microcomputers had limited power, CP/M did not provide sophistication for either developers or users. Updated versions have added concurrency, multiuser capability, and portability. Many of CP/M's features have become de facto standards because of CP/M's popularity on 8-bit computers; however, CP/M is hampered by its limited abilities.

MS-DOS: MS-DOS, designed for the newer 16-bit machines, remains largely compatible with the command syntax of CP/M. This has proven to be a winning strategy, and MS-DOS is very successful. At this time, MS-DOS is not portable and runs only on the 8086 microprocessor family. MS-DOS is evolving to more closely resemble Unix, by mimicking the tools approach and file structure, which is so useful for program development and applications.

Pick: the Pick operating system, an applications environment, was designed around databases and query facilities, which means it is easy to use. Because it permits programming only in BASIC, it is not efficient for math or computational applications. Of course, a good deal of data processing is concerned specifically with databases. Pick is portable and runs on a wide range of machines. Originally designed for larger machines, it has the sophisticated facilities business users demand.

Unix: the Unix operating system, designed by Bell Laboratories 10 years ago as a program-development base, originally ran on minicomputers. It is very portable and has migrated both up- and down-scale. Though a fine development system, until recently Unix lacked application programs and was not for the end user. It has always provided an integrated, consistent, and powerful environment to software developers through the tools approach. We'll discuss Unix's strengths, weaknesses, and potential in greater detail later.

Several operating systems are vying for a significant share of the microcomputer marketplace. The primary ones are CP/M, MS-DOS, Pick, and Unix.

Lisa: the Lisa-style operating system will have a profound effect on the front-ends of all future operating systems. A Lisa user sees a graphics display with pictorial representations instead of words. He operates the system by manipulating a mouse, which moves the cursor among the pictures (or "icons"), each of which signifies a command or the data to be handled. In addition, extensive use is made of windowing, which enables the user to see several displays at once.

Mice and windows are proliferating in new application designs even for other operating systems. For instance, Multitool-Word, a new word processor from Microsoft, uses a mouse and multiple windows, as do Visi On and the Unipress EMACS extensible screen editor for Unix.

Strengths of Unix

Unix has a reputation as the best environment for writing and maintaining programs, but it is considered a poor basis for end-user applications. We feel that the acclaim is justly deserved, but the negative sentiment is not as appropriate regarding applications use.

Unix is multiuser: because the cost of a machine is borne by several users, it can be lower than multiple single-user alternatives. Other operating systems are moving toward multiuser capability, but Unix has always had this facility.

A less obvious advantage of multiuser systems is the availability of shared data. Most applications rely on a database of some kind, and this data is usually of general interest to the user community. While networks of single-user machines can theoretically access a common data bank, in practice this is a cumbersome process.

Another inherent virtue of multiuser systems is the ability to develop software jointly. Large projects require many people, and the individually created components become integrated during the course of the project. Interim testing and final integration are greatly simplified when all the components reside on the same computer. MP/M, a member of the CP/M family, is available in a multiuser format, as is Pick. Lisa and MS-DOS 2.0 are not multiuser systems.

Multitasking capability: the process of running more than one program concurrently is another asset of the Unix system. This permits you to do more than one job at your terminal: for example, you could query a database while printing a lengthy report. Most microcomputer operating systems do not provide this capability, and even some mainframe operating systems limit the scope of multitasking. Unix has no built-in constraints on the degree of concurrent work.

Unix is the best program-development system: though most computer users are not programmers, they do rely on the programmers' creations. Thus, Unix applications can be particularly sophisticated because the development environment is so rich.

A number of standard languages are included in Unix, among them C, assembler, and FORTRAN. Pascal, COBOL, BASIC, and Ada are also available. C combines the efficiency of assembly-language with the control structures of modern high-level languages. Many applications exist for most of the other languages. Unix also provides several editors and debugging aids. The standard ed line editor is usually supplemented with the vi screen editor, which is now part of Unix System V.

The concept of reusable tools permits existing program segments to be strung together. Many applications require sorting of data, for example. Under most operating systems, the programmer must either write his own sort or obtain a commercially available one. Using this sort may be a separate job step. As one of its hundreds of built-in utilities, Unix includes a sort that can be run as a concurrent task or as a separate step. All of these utilities can interface with either terminals or files and communicate with each other. An example is the /RDB database package. /RDB is a collection of approximately 40 interacting tools that let you build a relational database without writing a single program.

An advanced file system: historically, operating systems organized files in a "flat" structure so that users' data and programs were commingled. As system complexities and disk sizes grew, flat file systems became intolerable. Unix provides a far advanced method of managing data and programs: the tree-structured file hierarchy.

In Unix, files are members of directories, which are themselves members of higher-level directories. Data and programs can therefore be organized coherently according to need. Any file or directory can be protected against unauthorized access. This protection extends to read/write/execute access for specific users, groups of users, and the entire user community. The file system is easily navigable from within programs or the command line.

Unix has extensive communications capabilities: standard Unix utilities transfer files between computers. In addition, the communications package permits a user to pass through one computer and log into another.

Weaknesses of Unix

The most often cited criticisms of Unix are its "user unfriendliness," its tendency to destroy files when the hardware crashes, its lack of record interlock needed to permit multiple, simultaneous write access to shared data, and the lack of a body of available applications. Until recently, the Bell System seemed unconcerned with the commercial potential of its Unix product and thus did not take the steps needed to ensure its success in the marketplace.

User unfriendliness: Unix was designed for computer professionals, an audience that appreciates terse command syntax because a minimum of keystrokes are needed to get results. Thus, to copy files you enter cp instead of "copy." This minimalist

philosophy extends to the Unix manuals, which require considerable study to comprehend. Few examples are given, which further makes the system difficult to learn.

In reality, Unix is no harder to use than any command-line-oriented system. You must learn the syntax of the commands, and Unix cannot be faulted for having so many commands; these commands, after all, are what give it great power. The commands use a standard format and syntax, unlike some competing products. In addition, the development of new menu-oriented shells is making Unix more accessible to the end user. The documentation is improving considerably, and numerous books have been written on Unix, which improve the learning process.

Propensity to destroy files: the criticism goes back a few years. Because Unix uses a "write behind" file mechanism to improve disk performance, there is a risk of file corruption or data loss if the hardware is not properly turned off (e.g., during a power failure). Such file losses occurred with regularity years ago; however, recent improvements have made Unix at least as robust as other systems.

Lack of record interlock: the lack of a record-interlock feature has been a serious impediment to widespread commercial use of Unix. Most data-processing applications require users to share a common database, and, as discussed earlier, Unix made shared

Unix comes with C and FORTRAN, and other languages are becoming available as demand increases.

data possible by its multiuser nature. Unfortunately, Unix did not protect these files against simultaneous write access, which created the risk of file degradation. Of course, application developers could arrange for their own protection, and many did. Even so, the operating system is the best place for such protection, and Unix has not had it until recently.

The Bell System: another criticism of Unix has been that it is a creature of the Bell System, whose interests may not correspond to those of the commercial computer world. This observation has certainly been valid, and as Unix progressed (without complete upward compatibility) from Version 6 to 7, and later from System III to V, observers had the right to feel that the system was too unstable for them to rely on.

Bell has clearly responded to those objections: the royalty fee has been reduced, the company has promised that it will not make future enhancements at the expense of compatibility, and Bell Labs has begun working closely with the major hardware manufacturers so that Unix can be available in a standard manner on all the popular 16-bit microprocessors.

Unix as an Applications Base

Unix is a sound vehicle for applications programs. The body of existing, commercially available Unix applications is not yet very large because until recently few microcomputer manufacturers supplied Unix with their machines. Applications are written as authors see a new market develop, and authors can reliably be expected to service the Unix area, just as they have flooded the MS-DOS arena, which did not even exist two years ago.

For years Unix has been the primary system in many research labs and engineering firms. These centers have designed many applications for internal use, and some of these are now appearing commercially.

Languages: Unix comes with C and FORTRAN, and other languages are becoming available as demand increases. Thus, both RM and CIS COBOLs, which are very popular on CP/M systems, now exist for Unix. BASIC from Microsoft and SMC have been ported. The first Ada implementations have been for Unix because Unix offered the best development base for its authors. Pascal, BASIC, and FORTRAN from SVS are

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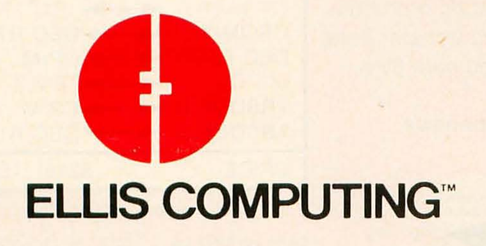
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Menu systems: the "user unfriendliness" issue has been disposed of by front-ends to Unix, which replace the command-line interpreter (shell) with a formatted screen that displays a menu. For example, Fortune and Altos Unix machines both include a menu shell. In addition, Unipress's menu system can be tailored easily either as a replacement Unix shell or as a front-end to any application. Properly configured menus can significantly reduce the learning period and error rates and guide the user.

Word processors and editors: Unix includes both word processors and text editors: the nroff/troff package is extremely powerful, although difficult to learn and use; the ed line editor has recently been supplemented with the full-screen vi product.

Software vendors are now providing excellent additional tools. The XED, Horizon, LEX, and the Fortune Forword word processors have features heretofore available only on dedicated word-processing machines.

EMACS is a screen editor that has migrated to Unix from its origins on DEC 10/20. This product has extraordinary powers; for example, multiple windows enable several files to be edited simultaneously, and a built-in compiled MLISP programming language provides great extensibility.

Spreadsheets: the microcomputer age was to an extent built upon the spreadsheet. Such programs are now available for Unix. The Unix environment is so powerful that spreadsheets like Ultracalc have no practical limits on the numbers of rows or columns. Unicalc is compatible with Visicalc and Supercalc. Both these spreadsheets are written in C, so they can be placed easily on any Unix machine. Multiplan is also available.

Database and ISAM: because Unix itself does not provide a keyed file mechanism, products have been written to fill this need. (Only Pick has been designed with a built-in database.) A variety of modern relational databases are now available. Mistress, Informix, Unify, Ingress, and /RDB are all tailored for Unix. Some of them also support query languages.

Programmers often want to access data based upon a key or index, without needing a full database system. The Phact ISAM (indexed sequential-access method) system from Unipress enables the C language programmer to build and maintain sophisticated multi-index, variable-length record, ISAM files. The Informix package also has an ISAM system.

Emulators: because so much software is designed for the older 8080/Z80 CP/M computers, several Unix software houses have written emulation packages that can interpret CP/M object code. This capability vastly extends the range of usable applications for Unix. Because Mimix, an emulator for CP/M, is written in C, it is portable and runs on PDP-11, VAX, 8086, and MC68000 Unix systems. The Bridge is another example. Emulators for MS-DOS, Apple DOS, and CP/M-86 should be available soon.

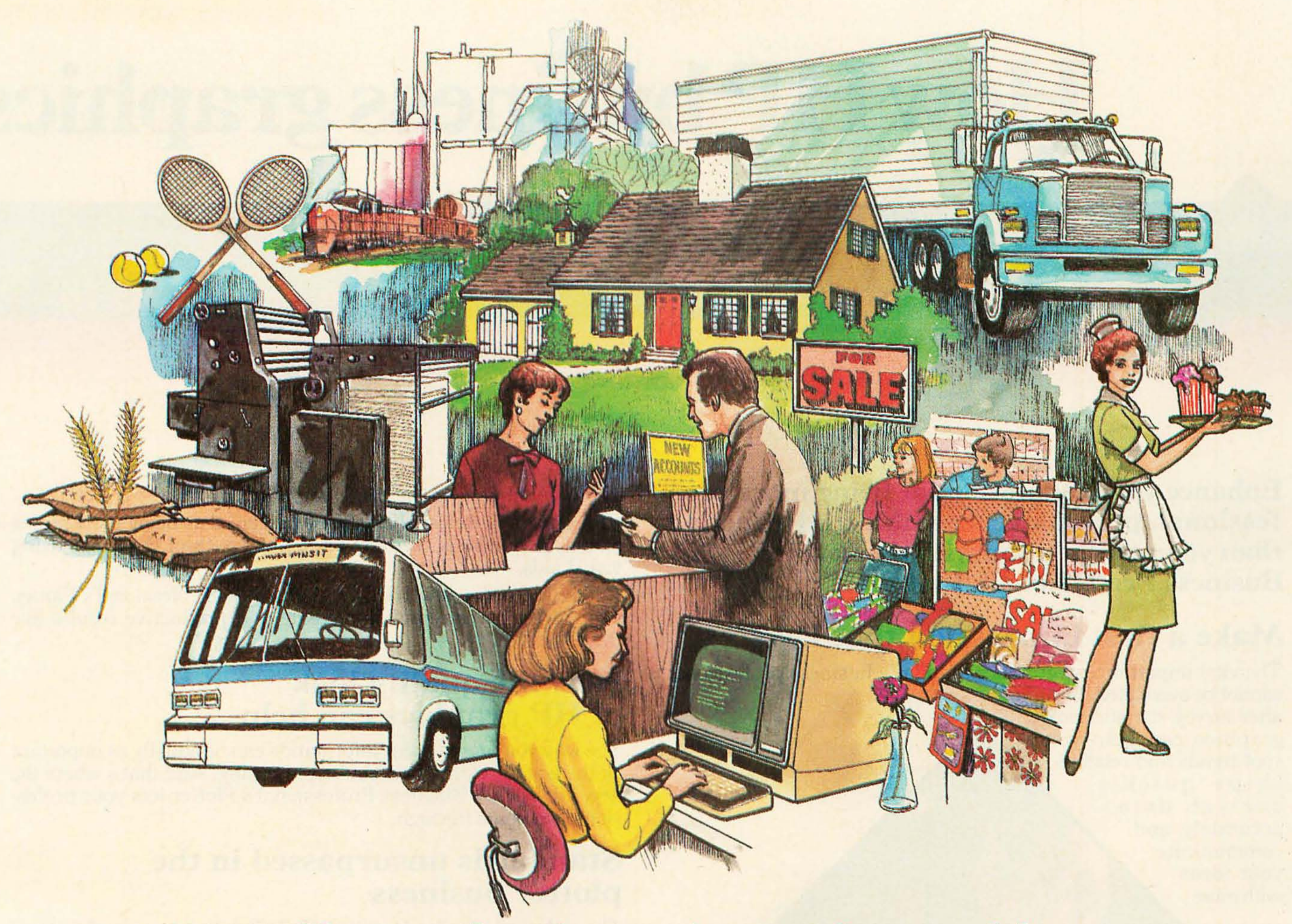
Business applications: the word processors and spreadsheets mentioned above are the first step toward full business applications. In addition, now that COBOL and BASIC function on Unix, a tremendous body of application software for business can be ported to Unix. The Open Systems and MBSI financial packages already function on Unix, and others are following.

Summary

This powerful operating system is demanding new applications; its software foundation is growing, and Bell Labs' decision to lower royalties and work with equipment manufacturers is giving Unix a needed push. As a result, great numbers of microcomputer users are being attracted by this multiuser operating system, no longer labeled unfriendly since the implementation of front-end menus. The Unix system is catering to the needs of both developers and end users, and a continued increase in widely known business applications will ensure that Unix meets its potential.■

Mark Krieger earned an M.S. in computer science from Pratt Institute and was a visiting computer scientist at CERN in Geneva, Switzerland. He is president and cofounder of Unipress Software.

Fred Pack earned an M.B.A. from New York University. He is vice-president and cofounder of Unipress Software (1164 Raritan Ave., Highland Park, NJ 08904).



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Usenet

A Bulletin Board for Unix Users

You can easily connect to a nationwide network of Unix enthusiasts

by Sandra L. Emerson

Although they aren't as well known as Unix text editors and program-development tools, Unix communications programs are powerful packages that provide access to Usenet, an electronic network that links Unix users around the country. You need only a Unix system and a modem to electronically send and receive mail, transfer files, and discuss the delights and frustrations of using Bell Laboratories' operating system. The comprehensive set of networking capabilities even enables you to log in to both a local and a remote system and work on the two simultaneously.

The Usenet Network

Usenet provides a set of programs (collectively called netnews) that allows messages to be posted in news groups, where user-defined topics are discussed. Anyone who has access to a Unix system running Usenet can participate in this network: there are no special membership requirements. The network is managed and maintained cooperatively by volunteers. Although no central administration exists, individual members who devote a significant amount of time to Usenet are generally considered opinion leaders when policy or strategy decisions are needed. Mark Horton, who works at a Bell Laboratories branch in Columbus, Ohio, is such a leader. Horton, who became interested in Usenet while at the University of California at Berkeley, helped develop the current Usenet programs. He points out that Usenet has grown from 50 sites two years ago to more than 500 today, with 5 to 10 new sites joining every month. In January of this year, Horton polled Usenet members to assess their feelings about a potential surge in membership resulting from the spread of desktop Unix systems now available at more popular prices. Although some members were concerned that the network might become overloaded, the general sentiment was in favor of continuing to allow anyone with access to a Unix system to join.

Participation in Usenet

To set up a Usenet site, you need a Unix system, a modem (preferably an auto-dial type), and disk storage to cope with the flood of messages that Usenet will unload once you are connected. It's not unusual for a large Usenet site to have more than 2 megabytes of messages in its queue.

The C-language Usenet programs run under the Unix operating system, but physical networks other than Unix's native uucp (Unix-to-Unix copy) can be used to carry the news: for example, gateways exist on a limited basis to the Defense Department's ARPANET and IBM's Bitnet. The majority of sites, however, use the uucp programs because they are already supplied with the rest of the Unix software and their use requires no special hardware.

Usenet members can sign up for any of several dozen news groups on topics ranging from assembly language to auto mechanics. And any user can start a news group. The Usenet community—currently made up of Unix users at universities, manufacturers and packagers of Unix systems, and providers of Unix-related services—has already built a large, unique, and occasionally rich database of news and commentary.

Usenet's History

The Usenet software was developed by a group of programmers—Steve Daniel, Tom Truscott, Steve Bellovin, and James Ellis—at Duke University in the spring of 1980. The first connection they made was to the neighboring University of North Carolina. Prior to the development of Usenet, Unix users could send electronic mail and files from point to point using the existing Unix network facilities, but no larger organizational framework or technical support was available for pooling news from a wide reading audience.

Version A of the Usenet front-end software was originally intended for use by the members of Usenix (university Unix users group) as a means

for online publication of their newsletter, but this implementation never really materialized. In the fall of 1980, Mark Horton at Berkeley learned of Usenet and became the first West Coast link. After the network was introduced at a Usenix meeting in Delaware, several more Unix sites were connected to it. Soon Usenet sites were scattered across the country; Oregon's Reed College and the University of Oklahoma were early members. Shortly afterward, programmers at Bell Labs (at the mother node in Holmdel, New Jersey) took notice, and Usenet was strengthened by the addition of Bell Labs personnel and facilities. With very little advertising, Usenet gained 50 member sites in its first year.

The Usenet software was originally designed to deal with a volume of one or two news articles per week. With an increasing volume of messages (the current level of activity is nearly 50 new articles per day), it became clear that new front-end software was needed. Aided by a talented young programmer named Matt Glickman, then a high school sophomore, Mark Horton and others at Berkeley rewrote the Usenet software early in 1982. The version B programs could handle the increased volume and, more important, could sort the messages by topic. Previously, messages for all news groups had been delivered in the order in which they arrived at the news machine. The version B programs (B News) contributed significantly to the growth of the network. The latest release of these programs is B News 2.10 (spring of 1983). The older form of the news programs, A News, is still in use at two of the original Usenet sites. A screen-editing front-end package called notesfiles is also available at some Usenet sites.

Between releases of front-end software, any Usenet member may suggest improvements or solutions for bugs and post them in a news group. They are then distributed to the network from news groups such as net.sources.

When a new member joins Usenet, a neighboring site sends a copy of the source for the news programs and documentation to the new site. Installing the programs and custom-tailoring them to individual needs is not particularly complicated; adequate disk storage, however, is quite important because the programs and documents themselves now consume about 700,000 bytes. Because of its size, the 2.10 B News release is being distributed in Unix tar format (suitable for tape or disk) instead of through the net.sources news group.

Finding your nearest local site is a key part of getting on Usenet, either as a new site or as a user. Because there is no central distribution point for the Usenet programs, the spread of both news and software depends on the cooperation of member sites in forwarding materials to their part of the network.

It's a Bulletin Board

Although the protocols of getting on Usenet and adding or reading messages are slightly more elaborate than those for The Source or CompuServe, Usenet does appear to the user as would most electronic bulletin boards. Messages are dated and posted in news groups, each of which is named according to the main subject matter of the messages it posts. Anyone entering a message must decide which news groups should receive it. Messages and announcements of general interest are posted to net.general. For example, net.general might announce the formation of new news groups, post trivia questions, and relate other miscellaneous messages.

As in many information utilities, each subscriber can select a personal list of topics. However, users may read articles from any news group at any time. The software can keep track of which articles have been read; unread articles are listed chronologically by publication date, beginning with the earliest.

Of the more than 500 official Usenet sites, most are at universities and Bell Labs research facilities. Each site that has an intelligent modem (and can therefore forward messages) agrees, by convention, to forward news to at least two or three other machines. This agreement cuts down on phone costs and helps distribute network maintenance. However, each region also has one or more backbone network machines that link to up to 50 Unix systems. Recently, manufacturers of Unix systems and software and providers of Unix-related services have been joining Usenet in increasing numbers. The user population might therefore be shifting from an academic and research community to one including many representatives from the outside world. The Usenet reading audience undoubtedly numbers in the thousands.

A Map of the Network

Of course, you don't have to be an official site in order to participate in Usenet. Many Usenet users simply obtain accounts on major network node machines, such as the nearest VAX, and dial into these machines to read the news. Users at official Usenet sites who have agreed to store and forward news set up uucp links with the network node machine and with their neighboring Usenet machines. The uucp programs function by queueing up work in a spooling directory and performing it at times specified in system files. The fact that the uucp process always involves copying—copying out work to be sent and copying in work to be received—is another reason that adequate disk storage is important for Usenet sites. Usenet sites poll the network on a regular basis, telephoning specific machines at agreed-upon times to send and receive work.

If you own a desktop Unix system, to join Usenet you will likely become an end node connected as a satellite to the nearest large Unix system. Particularly in the San Francisco Bay area, some manufacturers of Unix systems and software have been making their in-house development machines available on a limited basis for Usenet use.

Although no formal mechanism for network self-study is set up, interested users periodically measure the volume of traffic, make a map of the network, and even analyze the content of network news and post it to the appropriate news groups. Several

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different network maps have been produced according to various schemes. A list of longitude and latitude points of Usenet sites has also been published, but users comment that when lines are drawn to indicate links, the resulting map is quite confusing. Many cross-country links exist, and a geographical map of the network is therefore both hard to read and not particularly useful. Every few months, users such as Bill and Karen Shannon and Karen Summers Horton produce logical maps of the network. The Shannons' Usenet Logical Map (figure 1) is designed to be legible even in output from dot-matrix printers and will fit on one notebook page when reduced. As figure 1 shows, Usenet is a lumpy network, and, predictably, some of the largest nodes are supported by machines at Bell Labs. In recent months, the map has spawned an outrigger of West Coast Unix system manufacturers in its upper left quadrant, as witnessed by names such as Varian, Zehntel, Fortune, Altos 86, Sun, and Onyx.

Current News Groups

Presently more than 100 news groups are in Usenet, including several groups whose messages are piped to Usenet from ARPANET. News groups with the prefix "fa" come from ARPANET: those prefixed with "net" are of network-wide distribution, and news groups with no prefix are local ones.

What do Usenet users talk about? As might be expected, this community of Unix users devotes most of its energy, by volume of news, to discussing Unix itself. Because the Unix programs and utilities were developed over more than 10 years in relatively sheltered environments such as Berkeley and Bell Labs, such discussions could go on for years. Not only are there hundreds of utility programs in the standard Bell Labs Unix distributions, but dozens more are under development. Moreover, systems such as Whitesmith's Idris constantly sound variations on the Unix theme. Now that Unix is available commercially, dozens of applications programs are being developed, each

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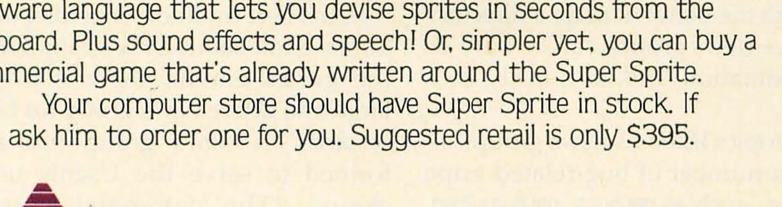
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```
USENET LOGICAL MAP - April 2, 1983
---------------------------------------------------------------------------
   az70         aus86  omsvax  orstcs   kirk         ism750  n44a  images  ico
     |            |       |      |        |             |     |      |      |
  arizona  ssovax--+=icalqa=+   hp-pcd--hp-cvd      cfib--+=====+==ima==+=====+
     |                    |      |                      |.    |    |    |     |
   kpno    nbires--cires  |      | hplabsb  hplabsc  inmet  imd  ipa | ism780
     |                |   |      |    |        |                     |
cvl  +====+=hao=======+=+--+===hplabs+=+========+-----sri-unix-------cca--csin
 |        |           | |           |                                |
rlgvax--+ |   crystal | csu-cs      hpda-------+      brunix--rayssd | cg-d
        | |      |    |             |          |          |          |  |
presby--seismo--uwvax |             hpdb--hpdc |      yale-comix--+===+==+===+==
  |       |           |                   |    |                  |   |      |
burdvax   | rocksvax  |      avsdF     hptabu  |  twg             | sultan   |
          |    |      |        |               |   |              |          |
ritcv--rochester   menlo70     avsdS--atd--dsd--fortune--wdll     |          |
         |            |        |                   |              |          |
   rocks34  syteka--sytek      avsdT   p500vax--megatest--sun--decwrl--amd70 |
                      |                            |      |       | |        |
          varian--zehntel--zps                   ubvax  altos86   | flairvax |
                      |                                           |          |
          crimson     |      tekchips  tekid               turtlevax         |
             |        |          |       |                                   |
     bronze--tekmdp----+=======tektronix==+=======+--ucbcad--+====ucbvax======+
             |        |                  |       |         |     |     |
          dadla-a  iddic      reed--teklabs  tekcad     populi | ucbonyx
             |        |                  |                     |
   dadla-b--dadla  tektinker  sequel--ogcvax--metheus--cdi   ucsfcgl    maxvax
             |                                                            |
          dadla-d          ul100s-------------------------ul100a     pegasus
                            |                              |            |
      +=====================|==npois===========+------------+=========+=====
      |                     |    |             |            |
      |          whuxlb     |  wbux5    sescent | cbosg      whuxk  hogpb------
      |             |       |              | |   |                   |
    npoiv------------eisx--pyuxbb      osu-dbs--cbosgd--nscs---rmc    hogpc  v---
     | |            |       |                  |            |              |
     | |    abnjh--pyuxll   |            mhuxd  mhuxi--aluxz  mork-cb    t--n
     | |                    |               |      |                       |
     | |        pyuxmm--pyuxdd  burl--mhuxv--mhuxj                         s
     | |                    |               |      |
     | |        pyuxcc--+==pyuxjj==+--mhuxm        |
     | |                |          |        |      |
     | |             pyuxk------pyuxl       |      |
     | |                |          |        |      |
     | |             pyuxss     pyuxvv      |      | uicsg  uiuccsl  moria
     | |                                    |      |    |       |       |
     | | research        hlexa--bwkna--mhuxh       | uicsl--+==+=uiucdcs====+----
     | |   |                                |      |        |              |
     | |   |  rabbit       mhb5c--+=mhuxa=+        |  uiucuxc--uiuceml  parsec
     | |   |    |             |  |         |       |        |              |
     | +--alice      princeton--mhb5b      mhuxt----+  uiucsrl    ihtnt     ctvax
     |       |                             |                       |
     |   mhtsa-----+====eagle=======+=====+           ihlpb    ihldt   ihpsl
     |       |      |               |      |            |        |       |
     |   mh3bs  allegra--psuvax  mit-vax  | ihaml  ihlts | ixlpa | ixn5k |
     |                              |      |   |      |    |    |   |    |
     |          dvlcn  slinac   masscomp  |  +=====+===+===+===+===+===+=====
     |             |     |                 |   |      |        |    |   |    |
     | wheps    psi  sask--hssg40--adec23  | ihnet  ihps4    ixlpc | ihwld |
     |   |       |    |                    |                      |        |
     | zeppo    utah-cs--utah-gr--pwa-b    | inmet--esquire      ihnpl  ih4ep
     |   |          |                      |  |
     +===+=========+======================+===+==================================
```

Figure 1: *An outdated example of the Usenet logical map. The double lines surrounding some site names indicate places with backbone machines for the network (at the time this map was created).*

of which could gather its own news and bug reports. The list of news groups changes constantly as new groups form and inactive ones die off. Like the network map, a directory of active news groups can be only an approximation and is quickly outdated.

The topics listed as news groups include a number of bug-related gripe sessions, such as net.bugs, net.bugs.2bsd, net.bugs.4bsd, net.bugs.v7, and last, but by no means least, net.bugs.uucp.

Three of these bug groups concern various versions of standard Unix; 4bsd, for example, refers to the Fourth Berkeley Standard Distribution, which operates on VAX and VAX-like machines.

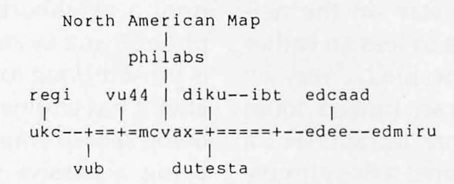
In the best tradition of getting one's information about Unix straight from the guru's mouth, there is a very large and active news group for Unix wizards. A news group has also formed to serve the Usenix users group. (The commercial users groups, /usr/grp and Uni-Ops, are not currently represented by Usenet news groups.)

Based on a title count at the time

```
------------------------------------------------------------------------------
  alberta--ubc-vision--sfucmpt   wjhl2--foxvaxl     utcsstat--utcsrgv--trigraph
            |  |   |               |                                |
    ubc-medgen | mprvaxa  grkermit--genrad--mitccc  wateng--watdaisy | dciem
               |                   |    |                  |        |    |
 teltone--uw-beaver--uw-june--uw70 |    linus--security   watmath---+==utzoo==+
          |                 |      |    |   |              |   |         |    |
  microsoft--fluke--vaxl   uw-vlsi | wivax  vaxine  watarts  watcgl    hcr    |
      |       |   |  |             |   |                                 |    |
      | ssc-vax  vax2   vortex  unh |   | medman--cwruecmp--cwrunix       |    |
      |                    |     |  |   |            |                    |    |
======++============+=====+=decvax=+===+============+=================+===+=====+
      |                                                                |         |
ittapp | ndcuts  tpdcvax     twin40--web40  mi-cec--idis--pitt--dri0 | adiron  |
  |    |   |       |                  |             |                 |   |     |
  +====ittvax==+=====+--bunker  ikonas--+===+=mcnc=+=+==+---+====duke+==+--phs |
  |    |      |      |                     |      |    |   |     |            |
qumix  sii  dcdwest  wxlvax          uvacs--ncsu   tucc--+unc+  ucf-cs--uf-che |
                |                         |       |      |      |              |
trwspf  trwspp +=====sdcsvax===+--sdchema  msdc    ecs  brl-bmd  fau            |
   |      |     |     |    |     |           |             |                   |
trw-unix--+     |  sdcsla  |  philabs--+     emory   udrelay   unm-ivax--nmtvax |
   |            |     |    |     |      |                        |              |
sdcrdcf--sdccsu3  phonlab |  micomvax | cmcl1  nybcb  rocky2  lanl-a  cubs45   |
  |      |      |  |       |           |   |      |       |       |      |      |
bmcg  sdcattb--sdcatta  noscvax        +===+====cmcl2=====+======+---esquire---+|
          |                                                       |            ||
      sdcarl           tpsa--spanky          e  f  g  j  (hocs*) |    sbcs    ||
                              |              |  |  |  |           |     |      ||
          594lux--machaids--hocda        d--+=hocsb==+--k          |    peri    ||
             |                 |             |                     |     |      ||
==houxm=====+ (houx*) q  r  y  +==houxz===+=+----hou5d--hou5a   +===floyd====+||
             |         |  |  |  |          |            |         |           |||
----b--+==+houxa+==+--+=houxi==+--p     ihps3           hou5e  vax135         |||
       |  |   |  |  |                                    |       |   |        |||
-h--j--k  c   f  o  hound  uofm-cv                 npoiv  hou5c  | cornell    |||
                              |                      |      |    |   |        |||
   bpa--sb6  scbhq   +---mb2b--uofm-hfh            hou5f--hou5b  | uw-beaver  |||
           |     |    |                                          |            |||
att3--lll--+====sbl===+--burl--kcwin--we53      houxe  orion--ariel           |||
        |                    |       |          |      |      |               |||
   +===+==otuxa======+---+====we13===+----------+=lime=+----houti--houca      |||
   |        |                        |          |      |      |               |||
we04-3b  nwuxc  inuxa  inuxb  inuxd  uniq       hoh-2  houxg  deimos          |||
   |        |      |      |      |                                            |||
princeton   +=====+==inuxc======+----ixn5c--druxs--drux[h-r,t-z]              |||
            |                         |                                       |||
--------pur-ee--iuvax--isrnix         |     iwlc8   iwsl1                     |||
          |  |                        |       |       |                       |||
 minn-ua  | ecn-pa--ecn-pb--ecn-ed    |  iwlc7--iwsl3--iwsl2                  |||
   |      |                           |       |                               |||
 umn-cs  purdue--------pucc-h--pur-phy |   ihps2----iwsl4--iwlc6              |||
   |      |                 |         |       |       |     |                 |||
 stolaf  ncrday--cincy  pucc-i   ihhfl |       |   iwsl5  iwsl6                |||
   |  |                            |  |       |                               |||
ihps3 |  ihnss  ixn5h  iheds  ihn5i |  |       | ihuxk--ihlap                  |||
  |   |   |      |      |      |    |  |       |   |      |                   |||
+=+=+=+==+=+=+===++==+===+===+==+=+=ihnp4======+===+======+                   |||
|  |   |  |  |  |     |    |  |                                              |||
| ihpad  | ixlpb | ixn5e   ihtpa  | ihux[a-j,l-u,w,x]                         |||
|        |       |                |                                           |||
ixn5d  ihima   ixn5c   cdlncch--laidbak--trsvax                               |||
                                                                              |||
=====harpo====================================================================+++


****************
* European map *
****************

EUROPE
```



```
                         North American Map
                                  |
                               philabs
                                  |
                  regi   vu44  | diku--ibt   edcaad
                    |      |   |    |          |
                  ukc--+==+=mcvax=+=====+--edee--edmiru
                           |             |
                          vub         dutesta



V>
```

of this writing, six out of the 100 active groups are discussing specific technical aspects of Unix. Another 16 news groups are concerned with other aspects of the computer industry. For example, six groups are discussing microcomputers, one group has an interest in peripherals, and another is addressing data communications.

In short, the Usenet online conference is somewhat like a real-time

control	net.games.emp	net.micro.pc	net.sf-lovers
fa.arms-d	net.games.rogue	net.misc	net.singles
fa.editor-p	net.games.trivia	net.movies	net.social
fa.info-terms	net.garden	net.music	net.sources
fa.info-vax	net.general	net.new.group	net.space
fa.info-vlsi	net.graphics	net.news	net.sport
junk	net.ham-radio	net.news.config	net.sport.baseball
msgs	net.invest	new.news.groups	net.startrek
net.ai	net.jobs	net.news.map	net.suicide
net.audio	net.joke	net.news.newsite	net.taxes
net.auto	net.jokes	net.nlang	net.test
net.aviation	net.jokes.d	net.notes	net.travel
net.books	net.lan	net.periphs	net.tv
net.bugs.2bsd	net.lang	net.pets	net.unix-wizards
net.bugs.4bsd	net.lang.c	net.philosophy	net.usoft.s
net.bugs.uucp	net.lang.pasca	net.physics	net.wanted
net.college	net.lang.pascal	net.poems	net.wine
net.columbia	net.mail	net.politics	net.wines
net.comics	net.math	net.railroad	net.wobegon
net.cooks	net.med	net.rec	net.women
net.cycle	net.micro	net.rec.caves	net.works
net.dcom	net.micro.68k	net.rec.photo	parents
net.emacs	net.micro.apple	net.records	
net.flame	net.micro.atari	net.religion	
net.followup	net.micro.cpm	net.rumor	

Table 1: *A list of active news groups compiled from a San Francisco Bay area news machine in May 1983. The* net.cooks, net.unix-wizards, *and* net.sf-lovers *were among the list's most active groups; each contained more than 500 current articles.*

conference composed mostly of academic, technically sophisticated computerists: their favorite play is their work. However, at least a third of the news groups are concerned with hobbies and recreation. Computer games—mostly of the Dungeons and Dragons genre—are well represented. There have also been groups on birds, boats, bridges, caves, coins, photography, and scuba diving. The news groups on science fiction (net.sf-lovers) and the *Star Wars* movies have attracted so much activity that some members have grumbled publicly about these "groupies" and the amount of disk space they consume. Because messages stay on the network for two weeks unless an earlier expiration date is specified, a very active news group can indeed loom large on the network terrain. (For a partial listing of Usenet news groups, see table 1.)

Usenet Site Requirements

The most important prerequisite for becoming a Usenet site is to know the location of the nearest existing Usenet site and the name and telephone number of the person in charge of it. You must have access to a Unix system and have system-manager (superuser) privileges in order to set up the uucp and netnews system files. You also need a modem, preferably an auto-dial one (to initiate transactions), and sufficient disk storage to handle the news flow.

With an auto-dial modem, your system can telephone other systems and initiate uucp work, including Usenet work. Such systems are called active uucp sites. When an active system initiates a uucp transaction, it telephones the remote system and allows that system to log in as a user. The active system then performs work for the remote system. Without an auto-dial modem, you must wait until a neighboring active site telephones your system, then your work is passed along to the active site only after it has emptied its queue of work being sent to your system. Although being a passive site is not a great limitation, you must arrange for an active site to poll your system on a regular basis. You can do so by exchanging tokens such as system names and setting up system files that contain phone numbers and calling times. Although an active site can poll 7 to 10 machines for work, the uucp link connects only two machines at any time.



Installing the uucp Programs

Installing the uucp programs is the first major hurdle a prospective Usenet site must clear. Some manufacturers of Unix systems, such as Intel, which makes the Xenix-based 86/330 system, are currently supporting uucp versions that are known to work. Although Microsoft's Xenix and Unisoft's Uniplus+ standard distributions include cleaned-up and newly documented versions of uucp, direct support from software suppliers ranges from limited to nonexistent.

The uucp programs were developed for much more restricted networking than they are currently being asked to sustain for Usenet and other uses. According to Mark Horton, the uucp programs have not been thoroughly revised since 1978, and they've needed many patches and fixes since then. Fortunately, Usenet itself has been the means of distributing many of these improvements, but most people who have tried to install the uucp programs would agree that they are remarkably temperamental. Paul Miller of Horizon Software Systems, who is currently writing a book with Charles Clanton on Unix system administration, enjoys using uucp but admits that the best way to get it up and running might be to hire someone who's done it before.

While I don't intend to provide here a complete guide to installing uucp, I can offer a few handy hints for system managers. Volume 1 of the *UNIX Programmer's Manual* (New York: Holt, Rinehart & Winston, 1983) provides additional instruction in the use of uucp under entries for uucp, uux, and mail. Tutorial papers, "A Dial-up Network of Unix Systems" and "Uucp Implementation Description" are included in volume 2 (part B).

Some of uucp's problems result from the nature of its assigned task. The ability of one system to log into another system (usually as a user named uucp) and receive or send files represents a fundamental breach of system security unless authorized access is verified. Many of uucp's failures are caused by lack of permission at some point in the transaction.

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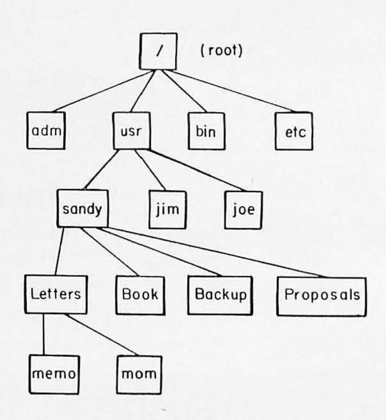


Figure 2: *This diagram represents part of a Unix file system tree. Beginning with root (/), it shows four directories in root, three user directories, and four directories owned by* sandy, *one of which (*Letters*) contains two files.*

flagged with a set of permission bits defining levels of access for the file's owner, the owner's group, and the general public. Access is defined as "read" (can read or copy), "write" (can edit), or "execute" (can execute a command or command file, or search a directory). Files are arranged hierarchically; beginning with the root of the file system, files are indexed in directories, which in turn point to other directories, and so forth (see figure 2).

The relationship of any file to the root directory is expressed as the file's path, which consists of directory names separated by slashes, ending in the file's name. For example, the file memo in the directory Letters might have the following path:

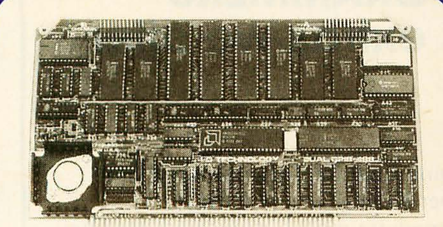
/usr/sandy/Letters/memo

(This user capitalizes the first letter of each of her directories so that they will be listed first in a directory listing.) The usr directory is a name conventionally given to the directory used to index the work of system users. When a user logs in, work is begun in the home directory, which usually has the same name as the account name. If the appropriate permissions are not in effect at any point in the path of a file involved in a uucp transaction, the transaction fails.

In addition to requiring appropriate permissions on the files and directories involved in uucp work, a number of system files are installed

i/o TECHNOLOGY

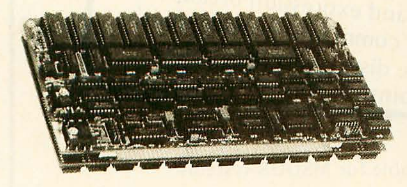
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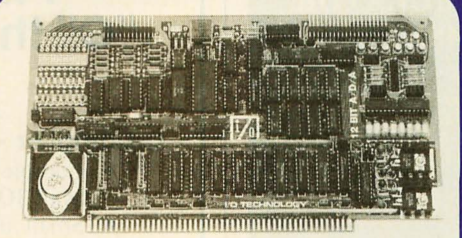


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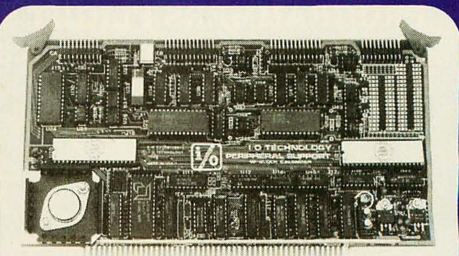
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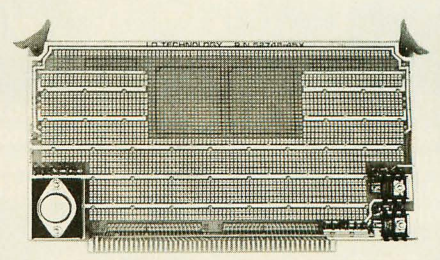
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in order to improve and refine uucp performance and security. These system files contain telephone numbers, site names, and access information used for linking to a remote machine.

The first requirement for performing uucp work is that a log-in name exist by which remote computers can identify themselves when they log in to your machine. Traditionally, the user name uucp is used, and an entry is made in the user account file, /etc/passwd.

Locations of uucp Programs and System Files

Most uucp programs and files are stored in four areas: a commands directory (such as /usr/bin), a library (/usr/lib/uucp), a system-administration directory (/etc), and the spooling directory (/usr/spool/uucp).

System files such as L-devices, L-dialcodes, L.sys, SQFILE, and USERFILE contain utility and security information. Each machine in the network has a uucp site name; a machine's own name is usually stored in a file in the /etc system-administration directory (e.g., /etc/systemname). The library file L.sys records the names of remote machines that will be logging in as uucp on your machine. Your machine's name, in turn, must be installed in the L.sys files of machines that yours will log into. The L.sys file must list the site names and connection information for all machines with which you plan to connect. A password for the uucp user may also be included in the L.sys file entry. Here are some sample entries from an L.sys file:

```
frobish Any tty13 1200 tty13 login:-
    EOT-login: uucp ssword: Uucp-psswd
usxvax Any ACU 1200 6328792 login:-
    EOT-login: uucp ssword: Uucp-psswd
cranshaw Any ACU 300 sr6760884
    login:-EOT-login: uucp ssword:
    Uucp-psswd
```

L.sys entries include the site name, calling times, the device and speed for the connection, and a simulation of the log-in sequence. The letters ACU in the sample entries stand for automatic calling device (or autodialer), and a telephone number that will be used by the intelligent modem appears. If no ACU is mentioned, the connection is assumed to be hardwired. Area codes and their abbreviations (such as "sr" for Santa Rosa, California) are stored in the L-dialcodes file, which is also in the library directory. The dashes and EOT symbols between log-in tokens indicate a pause, so that the modems and computers can synchronize with one another. Because the leading letters of "password" are usually lost in transmission, they are omitted in the L.sys file entry. There are many different opinions on the correct way to set up the L.sys file. Some installations, for example, also use ogin: for login:. If trial and error doesn't result in success, try to make your L.sys file congruent with those of the machines you will be calling. The L-devices file contains one entry for each device on which uucp may call out. For example:

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*Includes word processing hardware & multistation support. †Requires additional CP/M Hardware for your personal computer ($200-600 extra). CP/M is a registered trademark of Digital Research. *VisiCalc © is a registered trademark of VISIcorp. **Very similar program called Easywriter Professional, available for the Apple II.

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```
tty5 tty5 300
tty5 tty5 1200
tty2 0 9600
```

This sample L-devices file specifies that calls may be made at 300 or 1200 bps (bits per second) through device tty5. A hard-wire link to another machine through device tty2 operates at 9600 bps. If the L-devices file is empty, the site is defined as passive—incapable of calling remote machines.

USERFILE

The USERFILE restricts a local or remote uucp user's ability to access the local file system. Each entry in USERFILE may contain a user ID, a site name, and one or more path names. Each line specifies what areas of the file system a given user may access. The user can be a person logging into the system or a computer calling to perform uucp work.

For example, USERFILE could contain:


```
, /usr/public
root, /
uucp, /usr/public /usr/spool/uucp
```

The first entry allows any user (indicated by a null field followed by a comma) access to files beginning with the prefix /usr/public. The second entry allows the user root to access files beginning with the prefix "/"; this means those beginning with the root directory and extending to the whole file system. The third entry specifies that any remote computer logging in as uucp can access files beginning with the path /usr/public or /usr/spool/uucp.

Frequently, a shell script will be supplied with your uucp programs that will correctly set up the ownership and permission structure for the uucp files and programs. If no such script exists, a list of ownership and permission requirements is provided in the tutorial on uucp implementation.

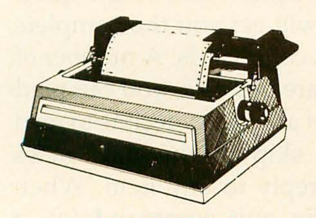
Information about uucp transactions is accumulated in several record-keeping files in the /usr/spool/uucp directory. Periodically, old log files should be removed in order to recover disk space. The secondary programs uulog and uuclean aid in maintenance work: uulog updates the uucp log file or, optionally, reports on its contents; uuclean removes old files from the spool directory.

Testing uucp

The quickest way to test whether you have correctly set up the uucp system files is to copy a file to another place on the local system, using the -x9 option to provide the maximum amount of debugging information. Once you succeed (return status 0), you can try calling or being called by a remote system. Of course, you must first telephone someone at the other end of the potential connection so that you can install each other in your system files in an agreed-upon way.

The syntax of the uucp command requires that each remote system name be followed by an exclamation point. Because uucp cannot deduce routing information on its own, each site name in a machine-to-machine

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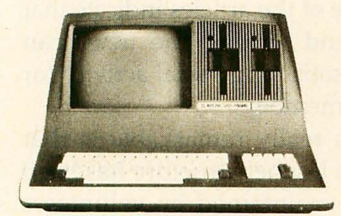
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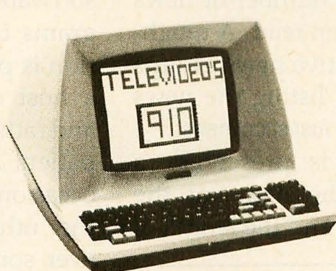
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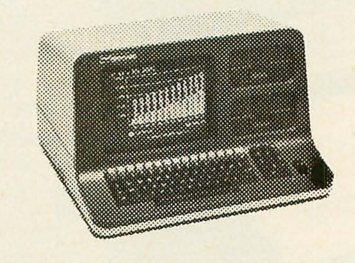
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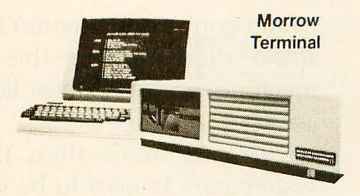


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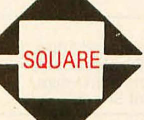
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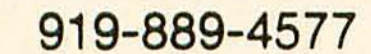
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path must be included on the command line. For example,

```
uucp -x9 /user/sandy/Letters/memo
  frobish!usxvax!cranshaw!/usr/arnold
```

would copy sandy's memo file to the arnold directory on the cranshaw machine via machines frobish and usxvax.

Currently, more than 1500 Unix systems are known to be uucp sites. A Usenet news group lists contact information for many of these machines. Mail and file-transfer services, as well as the Usenet news service, are supported.

On the Network

Once you have established a uucp link to your nearest Usenet neighbor, you can copy over the news programs and install them. Matt Glickman has written a *USENET Version B Installation Guide*, which should be part of the initial documentation you receive. One of the first articles you submit should go to net.news.newsite in order to provide contact information for use by the network. If you are planning to forward news to other sites, you must also install their site names and the names of the news groups to be forwarded in a sys file, which is similar to uucp's L.sys file.

Like other Unix programs, the news programs are simple commands with a number of options. On one command line, you specify what you want to do to whom and to what extent.

The basic Usenet news command is readnews, which forwards news to you from a default subscription list. Any user can custom-tailor the subscription list by creating a .newsrc file in the home directory. The news programs automatically update the .newsrc file with the number of news articles that have been read. A roughly accurate list of active news groups can be obtained by listing the news spooling directory, /usr/spool/news.

As each article is presented, a header indicates the name of the author, the subject, and the length of the article (in number of lines). A more detailed header giving the transmission path of the article is shown on request. Entering a question mark will get you the complete list of news commands. A number of responses are possible; you can read all or part of an article, decline to read an article, skip to the next news group, or reply to any item. When you use the quit command (q), a record is made of which articles you read or refused, and you then exit from netnews.

Usenet is remarkable for its nationwide scope and density of information flow, but in many respects it resembles other bulletin-board systems. Much of the dialogue concerns the operation (or nonoperation) of software, including the news programs themselves. Useful information is present but may be buried in a host of humdrum commentaries and rather trivial complaints. If you're patient and persistent, though, the occasional gems can make reading all that other news worthwhile. Moreover, some of the articles indicate that reading and writing the news can also be a satisfying social activity for network members.

What is really remarkable is that the whole Usenet structure has been built and maintained by volunteers and that thus far no heavy-handed central administration has been necessary. Usenet is an egalitarian communications medium, still open to new members because of the good will of its current members. The implicit social contract that exists among Usenet members—to forward news, respond to requests for information, and participate in network maintenance—will continue to be a vital part of Usenet.■

Acknowledgment

Thanks to James Joyce, who runs International Technical Seminars and The UNIX Bookstore, for suggesting this article and providing invaluable advice and support.

Sandra L. Emerson (309 63rd St., Apt. D, Oakland, CA 94618) is a freelance technical writer and coauthor of a book on the Unix operating system. She holds a B.A. in English from Duke University and an M.S. in health education from the University of Toronto.

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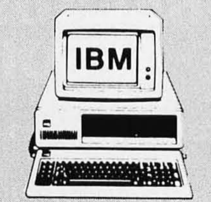
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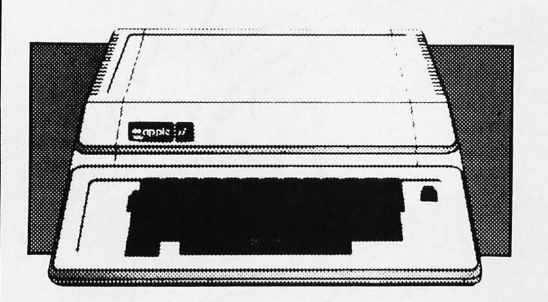
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HARDWARE
for Apple II/II+/IIe

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on disk for Apple II/II+/IIe

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by Lorinda L. Cherry and Nina H. Macdonald

The Unix Writer's Workbench software, consisting of programs and databases, is designed to help improve your writing. The package includes programs that identify mistakes and stylistic problems in your draft text as well as interactive programs to help you answer spelling and word-choice questions. Because the programs are general, you can use them with a variety of texts from letters to journal articles. You can also adapt the programs to meet your own needs. This article describes programs you might use in writing and revising a paper and how you can tailor the Writer's Workbench software to your own writing.

Writing Help

Let's set the scene. You have just finished a huge program and can no longer avoid writing it up. You have a Unix operating system and are either composing your first draft at the terminal or writing it off line, planning to type it in later. You're using the standard Unix mm (memorandum) or ms (manuscript) macros for formatting. In one sentence, you use the word "seperate"—or should it be "separate"? The spelltell program can help you find out with its database of commonly misspelled words. If you can spell part of the word, the program will return all the words on its list that match your entry. You type "sep.rate" or "^sep" or "rate$" and get the correct spelling, "separate." (The period stands for any character, the caret for the beginning of the word, and the dollar sign for the end of the word.) Next you want to describe the "affect"—or should it be "effect"?—of your program on its input data. The worduse program and its database, with explanations of about 700 commonly confused or misused words, can set you straight.

Proofreading Help

You've finished the first draft, it's stored in a file, and you now face the dreaded task of proofreading and revising it. It's time to put the main Writer's Workbench program, wwb, to work. The wwb program has two sections, proofr and prose, which may each be run separately; in fact, the Writer's Workbench system has a hierarchical structure, as shown in listing 1, and most of its smaller programs can be run independently. If you're a poor typist or speller, however, you should probably run spell on your paper before invoking wwb; the stylistic analysis part of wwb relies on the words in the text being spelled correctly.

Proofr first checks spelling and gives you a list of misspelled words (see listing 2). Next, it runs the punctuation checker, punct. The errors it finds include unbalanced quotation marks or parentheses, violations of the standard rules governing the order of punctuation marks, and sentences that do not begin with a capital letter. If you do not understand why the checker is complaining about your punctuation, type punctrules and get a display of the rules the punct program enforces.

Proofr then checks the text for "double" words; that is, a word occurring twice in a row. This common mistake is easier for the computer than a human proofreader to find. Proofr next gives the diction output, which displays sentences containing wordy or frequently misused phrases and recommends substitutions. Diction has a database of about 450 awkward or wordy phrases; each sentence in the text containing one of these phrases is printed with the unacceptable phrase set off in special marks (*[and]*). And sometimes, for the sake of efficiency, only part of the unacceptable phrase is bracketed. However, you should not assume the program is always right. Proofr also looks for split infinitives. If you don't recognize split infinitives or don't know why you shouldn't use them, call splitrules to

get information.

Help with Prose

Perhaps the most important section of wwb output is prose, which analyzes your writing style by using a program that finds parts of speech. Prose gathers statistics, compares them with a standard you choose, and explains in English how the text might be improved. If your text compares favorably to the standards, prose will tell you so. If your text differs greatly from the standards, prose will suggest ways to improve it (see listing 3). The program uses measures that writing experts agree lead to well-written text—varying sentence length and sentence type and avoiding the passive voice, for example.

With wwb output in hand, you'll probably want to start by making the changes suggested by proofr. These changes are fairly straightforward, but you will have to consider carefully the changes recommended in the section on word choice. It may be even harder for you to figure out how to follow the recommendations of prose. You can then run another program, style, to find all sentences with certain characteristics. For example, you can ask style to print all sentences with passive verbs, nominalizations, expletives, or all sentences longer than 50 words. (See listing 3 for definitions.) This output should give you an idea of where to start. If you have too many passive verbs, try the findbe program, which provides a formatted draft of your text highlighting all forms of the verb "to be." Go through this draft and try to rewrite the highlighted verbs to lower your count. If there are many long words in your article, use syl to find them; give an integer to syl—5, for example—and it prints all the words in your article with five or more syllables.

Finishing Touches

The Writer's Workbench system contains several programs that let you look at text in different ways. The org program, for instance, prints all headings and the first and last sentences of each paragraph. If your text is well organized, the output of org should be reasonably coherent and can be used as a basis for a summary of the paper. If the output isn't coherent, you may have a serious problem. No program can tell you how to reorganize your paper; you'll have to decide how to present it to your readers. Org may help you see that you have problems, but it doesn't correct them.

Suppose you also wrote a short document to tell a user how to implement your program. Did you assume that your user was male or female? Many people resent such assumptions. A quick run of your documentation through the sexist program will ensure you won't make such a mistake. Sexist is simply a variant of the diction program with a different dictionary of phrases and substitutions.

If you need keywords for your paper, the topic program helps by printing the 20 most frequently used noun and adjective-noun pairs in the text. Topic's output also gives you an idea of the subjects you've emphasized. A program called acro searches the text for acronyms, letting you

Listing 1: *A summary of the Unix Writer's Workbench system hierarchy.*

```
                         COMMAND-FUNCTION TABLE
-----------------------------------------------------------------------------

                               Commands
abst file..................evaluates text abstractness
acro file..................finds acronyms
findbe file................identifies difficult syntax
match stylefile1 2  N......collates statistics from different texts
org file...................shows text structure
parts file.................assigns grammatical parts of speech
sexist file................finds sexist phrases and suggests changes
spelltell pattern..........prints commonly misspelled words containing pattern
style file.................summarizes stylistic features
syl -n file................prints words of n syllables or longer
topic file.................provides clue to topic, keywords
    parts file.............assigns grammatical parts of speech
wwb file...................runs proofreading and stylistic analysis
    proofr file............gives proofreading comments
        ...................finds split infinitives
        diction file.........finds awkward phrases and suggests changes
        double file..........detects repeated typings of words
        punct file...........checks punctuation
        spellwwb file........checks spelling, using spelldict
    prose file.............gives extended editorial comments
        style file...........summarizes stylistic features
            parts file........assigns grammatical parts of speech

                              Explanations
prosestand.................prints standards used by prose to evaluate documents
punctrules.................explains punctuation rules
splitrules.................explains split infinitives
worduse word...............explains frequently misused or confused words
wwbhelp word...............gives information about commands and functions
wwbinfo....................prints a copy of this table

                          Environmental Tailoring
dictadd....................adds phrases to ddict, spelldict, sexdict dictionary
spelladd...................adds words to spelldict dictionary
mkstand....................builds standards for prose from user documents

                         User Specified Dictionaries
ddict......................personal list of awkward phrases
sexdict....................personal list of sexist terms
spelldict..................personal list of correct spellings
-----------------------------------------------------------------------------

Note. Indented commands are automatically run by the less
indented commands that immediately precede them.
```

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quickly check if you've defined them upon introduction.

Tailoring the System

Next, let's say you're finished with your paper and have submitted it for publication. The last time you ran proofr, however, it complained about the spelling of your last name and about that cute acronym you used to name your program. You can use dictadd to create your own supplementary file that will be searched automatically next time you use the Writer's Workbench system. Some of the phrases proofr complains about are appropriate in context. Use dictadd and make a private file of phrases; in the future, proofr will ignore some of its own phrases and use yours instead. Using this supplementary file concept, you can adapt the output of the Writer's Workbench system to your own needs.

Listing 2: *The* proofr *program's output for a first draft of this article.*

```
****************************** SPELLING ******************************

Possible spelling errors in byte_draft are:

meta              sep.rate          SPELLTELL
misspeled          seperate          WORDCHOICE
sep

If any of these words are spelled correctly, later type
          spelladd word1 word2 ... wordn
to have them added to your spelldict file.


****************************** PUNCTUATION ****************************

The punctuation in byte_draft is first described.

0 double quotes and 18 single quotes
2 apostrophes
0 left parentheses and 1 right ones
Because of the unbalanced parentheses, the following check for mistakes
may make errors.

The program next prints any sentence that it thinks is
incorrectly punctuated and follows it by its correction.

line 3
OLD: you have just finished a super program and
NEW: You have just finished a super program and

For more information about punctuation rules, type:
                    punctrules


****************************** DOUBLE WORDS ***************************

For file byte_draft:

the the appears beginning line 10 byte_draft

****************************** WORD CHOICE ****************************

Sentences with possibly wordy or misused phrases are listed next,
followed by suggested revisions.


For file byte_draft

beginning line 15 byte_draft
You *[ utiliz]*e the SPELLTELL program, an interactive program
with a data base of the most commonly misspelled words, to find
out.
```

Listing 2 continued on page 246

Suppose you decide the audience you usually address is much less sophisticated technically than readers of technical instructional manuals, and therefore you'd like different standards for prose. Or perhaps you have a favorite author whose style you would like to emulate. To adapt the software for such styles, you first have to gather text samples that reflect your standards. Because the Writer's Workbench system calculates statistics, you must have a reasonable number of samples on line—at least 20 samples of more than 2000 words each. Once you have the text in files, the mkstand (for "make standard") program will calculate all the statistics necessary for prose. Subsequently, when you run the program, you can have your text compared to your own standards rather than those of the system.

How It's All Done

The proofreading programs look at *all* the words in the text. The stylistic programs, on the other hand, separate the words in sentences from the words in headings and figures and tables. Those words should not be included in any counts of words in sentences, nor should they be included as part of any sentence. Writer's Workbench programs use embedded formatting commands to discard nonsentence text. Users of the Unix formatting macro packages label their nonsentence text with macros for headings, tables, centered lines, and other displays that are not part of the regular text. Thus, the stylistic programs can figure out which characters to include in their analyses. Word-processing systems in which a typist types as though on a typewriter do not allow this analysis, and the Writer's Workbench stylistic programs would be difficult to implement with such systems.

Conclusion

The programs we've described are not designed to do everything for a writer; rather, they remove some of the tedious burden of proofreading and provide guidelines about style. In this way, they free writers to examine their organization and content.

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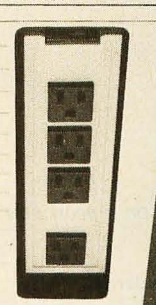
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Listing 2 continued:

```
beginning line 27 byte_draft
*[ Through the use of]* WORDCHOICE you discover the difference.

beginning line 27 byte_draft
WORDCHOICE is also an interactive program and has a
*[ very]* large data base of the commonly confused or misused
words.

file byte_draft: number of lines 29 number of phrases found 3

Please wait for the substitution phrases


------------------ Table of Substitutions ------------------

PHRASE                  SUBSTITUTION

through the use of: use "by, with" for " through the use of"
utiliz: use "use" for " utilize"
very: use "OMIT" for " very"
very: use "doubtless, no doubt" for " there is very little doubt that"
very: use "in a sense or OMIT WHOLE PHRASE" for " in a very real sense"
very: use "unimportant" for " of very minor importance"

-----------------------------------------------------------------


   * Not all the revisions will be appropriate for your document.
   * When there is more than one suggestion for just one bracketed
     word, you will have to choose the case that fits your use.
   * Capitalized words are instructions, not suggestions.
   * To find out more about each phrase, type "worduse phrase."

NOTE: If you want this program to look for additional phrases
      or to stop looking for some, for instance to stop
      flagging "impact," type the command dictadd.

May 19 17:08 1983 PROOFR OUTPUT FOR byte_draft Page 3

************************** SPLIT INFINITIVES ***********************

For file byte_draft:

Possible split infinitives:
to now describe

For information on split infinitives type:
                              splitrules
```

Listing 3: *The* prose *program provided these comments on a poorly written technical paper.*

```
NOTE: Your document is being compared against standards
derived from 30 technical memoranda, classified as good
by managers in the research area of Bell Laboratories.

READABILITY

   The Kincaid readability formula predicts that your text
can be read by someone with 16 or more years of schooling,
which is rather high for this type of document.   Good
technical papers average close to 13th grade level,
even though the audience has more education than that.

   This text includes many long words.  Consider running
the syllable counting program, syl, to look at the words in
this text with five or more syllables. To do this type the
following command when this program is done.
```

Listing 3 continued on page 248

The programs were designed hierarchically; casual users can get a lot of information with just one command, and experienced users can run individual programs when necessary.

The Writer's Workbench software has been very well received by writers who have used it. They report that they like getting information about their papers privately; only the computer knows. They prefer specific suggestions to comments such as "vague" or "poorly written" that they often get from human reviewers. Many claim their writing has improved simply because the system has prodded them to think about the choices they make when writing.■

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Lorinda Cherry has a master's degree in computer science. She is a member of the technical staff of the Computing Science Research Center at Bell Laboratories (600 Mountain Ave., Murray Hill, NJ 07974).

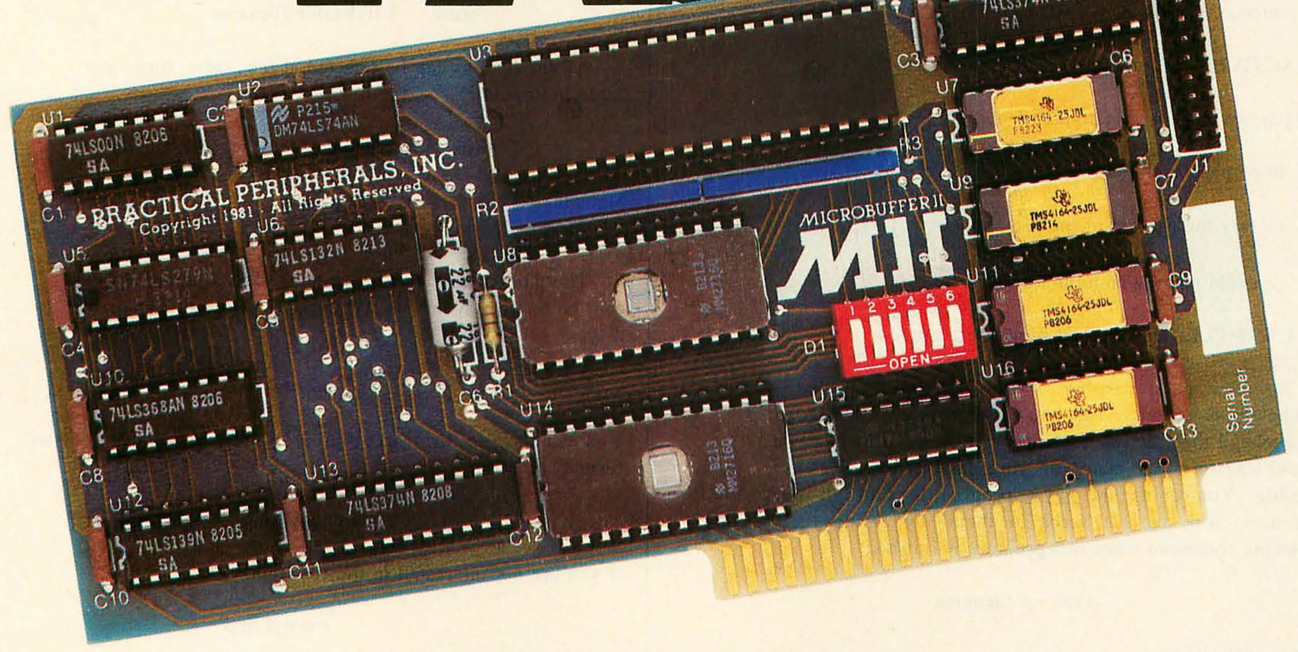
Nina H. Macdonald holds a doctorate in linguistics from the University of Michigan and works at Bell Laboratories (6 Corporate Pl., Piscataway, NJ 08854).

Where to Learn More

To find out more about the Unix Writer's Workbench software that was announced at the July 1983 Usenix conference, contact

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Listing 3 continued:

```
syl -5 filename
```

If most of the long words are technical terms that you must use, consider providing a glossary of terms to make this paper easier to read. If the words aren't technical terms, use shorter words wherever you can. In changing your text, be sure not to use several different words for the same concept; such synonyms are frequently confusing to the reader.

VARIATION

You have an appropriate distribution of sentence types.

SENTENCE STRUCTURE

Passives

This text contains a higher percentage of passive verbs (32.0%) than is common in good documents of this type (22%). A sentence is in the passive voice when its grammatical subject is the receiver of the action.

PASSIVE: The ball was hit by the boy.

When the doer of the action in a sentence is the subject, the sentence is in the active voice.

ACTIVE: The boy hit the ball.

The passive voice is sometimes needed

1. to emphasize the object of the sentence,

2. to vary the rhythm of the text, or

3. to avoid naming an unimportant actor.

EXAMPLE: The appropriations were approved.

Although passive sentences are sometimes needed, psychological research has shown that they are harder to comprehend than active sentences. Because of this you should transform as many of your passives to actives as possible. You can use the style program to find all your sentences with passive verbs in them, by typing the following command when this program is finished.

```
style -p filename
```

Nominalizations

You have appropriately limited your nominalizations (nouns made from verbs, e.g., "description").

Expletives

This text contains a higher percentage of expletives (8.0%) than is common in good documents of this type (3%). Expletives are words that have no content. For instance, "it" and "there" are often used as expletives in sentences such as "It is dark" and "There are three solutions to this puzzle." In these sentences, "it" and "there" have no content; they are simply linguistic placeholders.

Expletives are sometimes necessary, e.g., "It is raining." Often, however, they add unnecessary words to a sentence: "There are three solutions to this puzzle" can easily be shortened to "This puzzle has three solutions."

To find all the expletives counted by this program, type the following command after this program is finished.

```
style -e filename
```

PROSE OUTPUTS

Options

You can request that your document be compared against different standards; typing -t with the prose command, e.g.,

```
prose -t filename
```

will compare your text against training documents.

A -s option will provide a very short version of the prose output.

```
prose -s filename
```

If you already have a style table in a file, you can save time by using it as the input to prose rather than the textfile. To do this, precede the style table filename with a -f, e.g.,

```
prose -f styletable-filename
```

All the options can be selected at the same time and listed in any order.

```
prose -f styletable-filename -s -t
```

Statistics

The table of statistics generated by the program style can be found in your file styl.tmp. If you want to look at it type:

```
cat styl.tmp
```

You can also use the match program, which provides a better format, type:

```
match styl.tmp
```

If you are not interested in the file, remove it by typing:

```
rm styl.tmp
```

ORGANIZATION

The prose program cannot check the content or organization of your text. One way to look at the overall structure of your text is to use grep to list all the headings that were specified for the mm formatter. To do this, type:

```
grep '^.H' filename
```

You can also use the organization program, org, to look at the structure of your text. Org will format your paper with all the headings and paragraph divisions intact, but will only print the first and last sentence of each paragraph in your text so you can check your flow of ideas.

```
org filename
```

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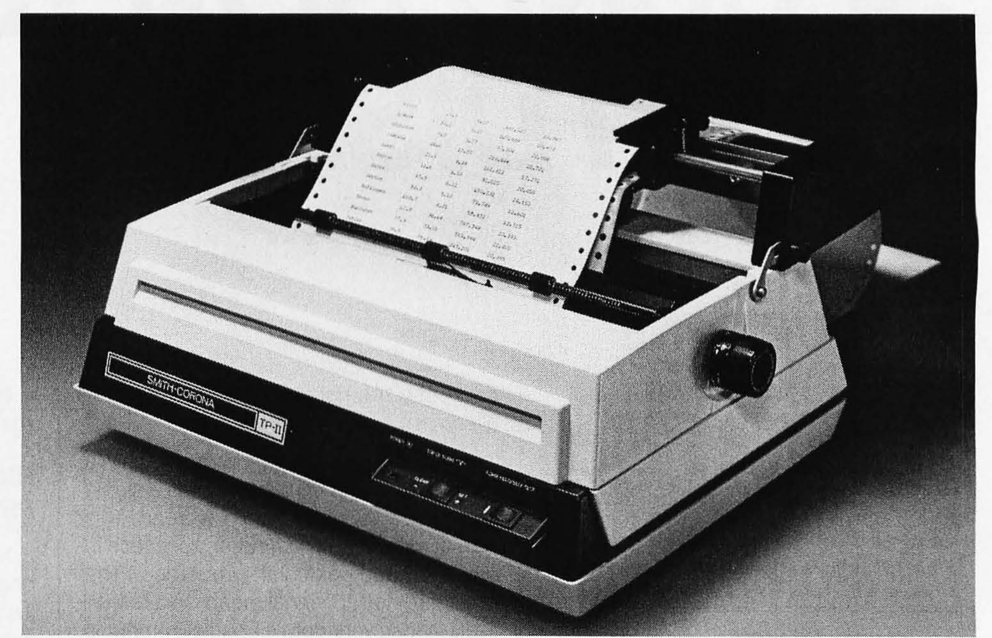
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Typesetting on the Unix System

The formatting and typesetting system built around the troff program works reliably and can be learned in a day

by Bill Tuthill

The Unix text and formatting system, based on the troff (Typesetter RunOFF) program, is the mainstay of document preparation at Bell Laboratories as well as many universities and research institutions. Offered free of charge with any computer that runs Unix, troff (pronounced tea-roff) is a dependable system that is easy to learn. Studies have shown that Unix composition is about 2.5 times as fast as typewriter composition and costs a third less (see reference 5). The current facility provides special languages that make tables, equations, and bibliographies easy to specify and format. Without change, it can have the same text file line-printed, typewritten (perhaps with proportional spacing), and phototypeset for publication. In newer releases the typesetting system also provides languages for drawing diagrams within a document.

The troff program was written in PDP assembly language in 1973 by Joseph Ossanna. The nroff program (New RunOFF) was devised to drive typewriter terminals instead of a typesetter and shares source code with troff. Updated programs were rewritten in the C language around 1975 and evolved slowly but steadily until late 1977, when Ossanna was killed in an automobile accident. Because nobody else knew exactly how troff worked, its evolution came to a halt.

Offshoots of troff

Other programs later grew up around troff: tbl for producing complex tables, eqn for typesetting mathematical equations, and refer for handling bibliographic references. These programs are preprocessors for troff. That is, they look for appropriate areas of text and transform a high-level specification language into low-level typesetting codes. These codes are then passed from the preprocessors to troff using the Unix pipe mechanism. The functionality the preprocessors provide could never have been built into troff itself given the memory constraints of the time when troff was first used.

The original troff allowed for only four fonts and 15 point sizes; the new one permits 256 fonts and 128 point sizes.

Another advantage of preprocessors is that existing ones can be changed, and new ones written, without modification of troff itself. Thus, the modularity provided by the Unix system allowed typesetting software to grow through accretion into the full, mature system it is today.

The first versions of troff produced typesetting code only for the Graphics Systems (later Wang) CAT/4. In late 1979 Brian Kernighan began rewriting troff to produce intermediate ASCII (American National Standard Code for Information Interchange) code, which could then, theoretically, be converted to binary codes for any typesetter. In 1982 this software was released to the public.

Educational source licenses cost $300 per processor, and commercial source licenses sell for $4000 per processor. Both are available only to Unix license holders. The distribution tape includes translating programs for the Mergenthaler Linotron 202, Compugraphic 8400, and Autologic APS-5 phototypesetters and the Imagen Canon LBP-10 laser printer. Note, however, that recent releases of Unix, including 4.1 BSD and System V, do *not* include the new device-independent troff.

The original troff allowed for only four fonts and 15 point sizes; the new one permits 256 fonts and 128 point sizes. In addition, the former line-length limit of 7.54 inches has been lifted. The new troff also provides graphics primitives for drawing diagonal lines, circles, ellipses, arcs, and splines. Two new preprocessors, pic and ideal, provide a way to include diagrams in typeset documents. Pic is simpler and thus easier to learn, but ideal provides more powerful con-

structs for shading and opaquing. Unfortunately, neither program is as easy to use as Lisa Draw because they require that diagrams be specified linguistically rather than graphically.

The coding and design of troff are often criticized. It is true that its old C source code is largely uncommented, but it is also well organized and has proven extremely robust. The native input syntax is terse and unnatural, yet it is sufficiently general that macros at the user level are natural, mnemonic, and extensible. Troff is also criticized for its voracious appetite for computer resources, particularly when used in conjunction with the preprocessors. However, some typesetting systems are even worse. Let's face it: the computing required for text processing is inherently much greater than that required for numerical processing. Strings take up more space in memory than numbers; calculating character widths and filling and adjusting lines require a lot of number crunching.

Other Formatting Systems

Most formatting systems that run on mainframes are based on the runoff formatter written at MIT in the early 1960s. The idea behind that formatter was to mix text and formatting directives in the same file. Formatting commands appear on lines starting with a period, whereas text lines do not start with a period. With this type of formatter, which could be called a batch system, files are prepared with a text editor and then material is run off with a separate program. The troff program descended from runoff and uses the same arrangement to specify commands.

Today, most word processors that run on microcomputers are interactive—files are formatted while you are entering text, using one unified program. In many ways this arrangement works better than a batch formatting system, because you aren't surprised by unusual results when you run off a file for the first time. However, the theory that "what you see is what you get" also implies that "what you see is *all* you get." Wordstar, for example, does not provide proportional spacing on a daisywheel printer, let alone the ability to do phototypesetting, mathematical equations, and complex tables.

The troff system has two principal competitors: TEX, from Stanford University, and Scribe from Unilogic. (In addition, many commercial typesetting systems are available that do not compete directly because of their high cost and because they do not run on general-purpose computers.)

TEX was developed in 1978 by Donald Knuth at Stanford. Parts of it, especially its equation-formatting capability, were inspired by the eqn program on Unix. The strength of TEX lies in its algorithms for boxes,

Batch formatting may produce unusual results but offers more powerful options.

paragraphing, hyphenation, and "glue." TEX considers text objects (such as paragraphs and lists) to be boxes separated from each other by stretchable glue. Entire paragraphs are held in a data structure then output all at once to prevent orphans and widows. (An orphan is a *single* line from the beginning of a paragraph appearing at the bottom of a page, and a widow is a single line from the end of a paragraph appearing at the top of a page.) Hyphenation is avoided, if at all possible, simply by measuring how much room is left on the final line of a paragraph and placing extra words there. By contrast, troff works a line at a time. Therefore, widows and hyphenation problems occur every now and then, although orphans can easily be avoided.

The first version of TEX was written in Sail; newer versions are in a nonstandard version of Pascal. The principal drawbacks of TEX are that it is difficult to learn and use and poorly documented. Its input language is baroque and hard to read, and no useful beginner's manual is available—the one book by Knuth must suffice. In addition, many symbols required by TEX are not available on standard ASCII keyboards. Tables are difficult to specify using TEX, no bibliographic tools are provided, and TEX has no graphics language. On the other hand, Knuth's Metafont provides a means of describing and creating entirely new symbols. Support for various output devices, both laser printers and typesetters, has improved. TEX was chosen by the American Mathematical Society as its standard document-formatting language. The American Physical Society chose troff as its standard language.

Arguably the easiest to use of all the batch formatting systems, Scribe was written in 1979 by Brian Reid at Carnegie-Mellon University and is now marketed by Unilogic Ltd. in Pittsburgh. Although not so much simpler to use that it can hold its own against interactive mouse-driven systems, the Scribe formatter does accommodate different types of documents (such as letters, articles, theses, books) and high-level text constructs (such as paragraphs, titles, and headers). Document types and text constructs are defined in an easily modified Scribe database. This system's beginner-level manual is excellent, as is the documentation for more advanced users.

Scribe has two principal drawbacks, however. Its licensing cost is relatively high, and the current version has no facility for producing mathematical equations, although such a feature is promised for future versions. Tables are fairly difficult to specify using Scribe, and it provides no graphics language.

Some users also complain that Scribe is verbose; when converting Scribe input to troff input, deletion is the most common operation required. However, Scribe support for different output devices is (and always has been) excellent. In addition to supporting typesetters that the new troff supports, and some that it doesn't, Scribe supports the Xerox 9700 laser printer.

Typesetting with troff

To use the troff system, you enter text and interspersed formatting commands (lines beginning with a

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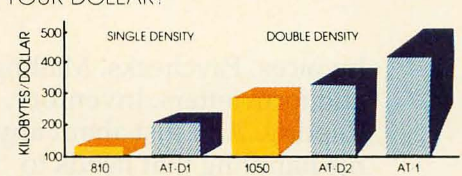
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period) into a file using a text editor. Most people use vi (pronounced vee-eye and standing for visual), a screen editor developed at the University of California. Some installations prefer the Rand editor in one of its many incarnations (ned, red, ined, e) or some version of emacs, originally from MIT and the inspiration for MINCE and Perfect Writer. All these editors are screen oriented. Some diehards and underprivileged typists still use line editors such as ed, which makes them far less productive than they would be using a good screen editor.

When you are ready to run off the text, the file is written to disk and the nroff formatter is invoked:

```
$ nroff -ms file
```

A macro package (such as -ms) is almost always involved because it provides pagination and common text structures such as headers, paragraphs, footnotes, and displays. Here is a short list of the most frequently used -ms macros:

.TL	title
.SH	section header
.PP	paragraph
.DS	display start
.DE	display end
.FS	footnote start
.FE	footnote end

The nroff formatter provides typewriter output. If you want to typeset the file, this command would be used instead:

```
$ troff -ms file
```

Theoretically, it would not be necessary to change the file. However, lineation and pagination are different with troff because the typesetter packs more words per line and thus more words per page.

If the text had particularly tricky tables, you might want to employ the tbl preprocessor:

```
$ tbl file | nroff -ms
```

or

```
$ tbl file | troff -ms
```



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Compucenter
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ARIZONA
Tab Products of Arizona
Phoenix, 602/864-0311
ARKANSAS
Parkin Printing & Stationery
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Orange County, 714/633-6650
Informco
Van Nuys, 213/994-3380
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Santa Monica, 213/450-0132
Jeskin Products
San Diego, 714/489-0121
Kierulff Electronics, Inc.
Offices Nationwide,
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213/725-2325 (in CA)
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Data Pro, Ltd.
Denver, 303/777-8655
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Tampa, 813/223-7194
Data Pax
Miami, 305/446-9291
Kar Printing
Hialeah, 305/557-4782
National Data Products
Tampa, 800/237-3875
Pinellas Processing Supplies
Largo, 813/224-0466
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(1a)

```
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.TS
allbox;
cfB s s s s
c c c c c
l l n l l.
.sp
\s+2Northern California Whitewater\s-2
.sp
\fIRiver          Class   Length   Season   Comments\fR
Lower Klamath    2-3     25 mi.   summer   warm water and pleasant scenery
Cal Salmon       4-5     21 mi.   spring   extremely technical, many rocks
Yuba N Fork      3-4     9 mi.    spring   portage 10 ft. waterfall at end
American N Fork  4-5     13 mi.   spring   beautiful, several portages required
American Middle  3-4     17 mi.   summer   has tunnel through rock, 3 portages
American S Fork  2-3     18 mi.   summer   most popular whitewater section
Stanislaus       2-3     9 mi.    summer   inundated by New Melones Reservoir
Tuolumne         4-5     18 mi.   summer   continuously difficult and fast
Merced           3-4     14 mi.   spring   no dams above, very cold water
Carson E Fork    2       20 mi.   spring   scenic, includes hot springs
Truckee          1-3     25 mi.   spring   scenic, easy access, variety
.TE
```

(1b)

Northern California Whitewater				
River	*Class*	*Length*	*Season*	*Comments*
Lower Klamath	2-3	25 mi.	summer	warm water and pleasant scenery
Cal Salmon	4-5	21 mi.	spring	extremely technical, many rocks
Yuba N Fork	3-4	9 mi.	spring	portage 10 ft. waterfall at end
American N Fork	4-5	13 mi.	spring	beautiful, several portages required
American Middle	3-4	17 mi.	summer	has tunnel through rock, 3 portages
American S Fork	2-3	18 mi.	summer	most popular whitewater section
Stanislaus	2-3	9 mi.	summer	inundated by New Melones Reservoir
Tuolumne	4-5	18 mi.	summer	continuously difficult and fast
Merced	3-4	14 mi.	spring	no dams above, very cold water
Carson E Fork	2	20 mi.	spring	scenic, includes hot springs
Truckee	1-3	25 mi.	spring	scenic, easy access, variety

Figure 1: *Through use of the* tbl *preprocessor, the input in 1a resulted in the attractive table shown in 1b.*

Simple lists can be done by hand, but it's difficult to make them work properly on both a typewriter and a typesetter. If you fail to call the tbl program, junk will appear in place of a good-looking table. See figure 1 for an example of table input and output.

If the text contains mathematical equations, you will want to invoke the eqn preprocessor:

```
$ neqn file | nroff -ms
```

or

```
$ eqn file | troff -ms
```

The neqn variant is used for typewriters, while eqn is used with a typesetter. Both programs, developed by a compiler-compiler, translate a simple context-free grammar into appropriate formatting commands. See figure 2 for an example of equation input and output.

The refer preprocessor can be used to deal with bibliographic material. The pic and ideal languages provide for the inclusion of graphics into a document. Tables of contents, as in figure 3, can be collected and generated automatically or produced as an afterthought.

Documentation Guide

The troff system is a well-documented one. The original manuals from Bell Laboratories are not suitable for beginners, however, because they are organized by program rather than in tutorial order and assume far too much knowledge on the part of the reader. Better material is available, though. For people with

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- Daisywriter 2000 w/48K ... Call

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- CR-1-P ... $755
- CR-2 ... $449

Datasouth
- DS180 ... $1155

Diablo
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- 630 RO ... $1699

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- 380Z ... $1080

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- Microprism 480 ... $480
- Prism 80 ... $1160
- Prism 80 Color ... $1345
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Juki
- 6100 ... Call

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- All models ... Call

NEC
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- PC-8025 ... $669
- 3510 ... $1365
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- 2010 ... $785
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- 82A ... $385
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- 84P ... $975
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Qume
- 1140 w/interface ... $1369

Silver Reed
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- Delta ... Call

Tally
- MT 160L w/Tractors ... Call
- MT 180L w/Tractors ... Call
- Spirit 80 ... Call

Toshiba
- P1350 ... $1445

Transtar
- 120P ... $449
- 120S ... $429
- 130P ... $669
- 130S ... $709
- 140S ... $1179
- T315 ... $449

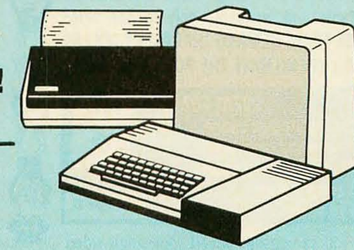
Rana
- Elite 1 ... $245
- Elite 2 ... $380
- Elite 3 ... $490
- Controller (w/Drive only) ... $75
- 1000 (For Atari) ... $290

TRAK
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- ATD-2 ... $375

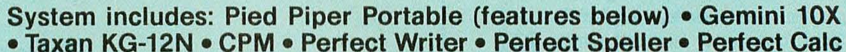
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- 970 ... $975

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11/83

(2a)

```
.EQ
gsize 12
alpha over {2 pi} int from 1 to omega ~
left { sum from k=1 to inf sin sup 2 X sub k (t) right }
left [ f(t) + g(t) right ] cdot sqrt {lambda over phi}
.EN
```

(2b)

$$\frac{\alpha}{2\pi}\int_{1}^{\omega}\left\{\sum_{k=1}^{\infty}\sin^{2}X_{k}(t)\right\}\left[f(t)+g(t)\right]\cdot\sqrt{\frac{\lambda}{\phi}}$$

Figure 2: *Example of input (2a) and the resulting equation (2b) set using the* eqn *preprocessor.*

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Figure 3: *Information for a contents page like this one can be gathered and generated automatically or collected later in the production cycle.*

PRINTERS

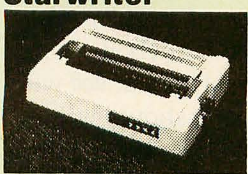
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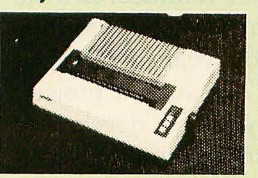


Letter-quality, 40 cps, 136 columns (Diablo 630 code). The **Printmaster** is the 55 cps version. Serial or parallel interface.

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Printmaster **$1679.88**

EPSON

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RX-80 .... **$399.88**
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MX-100 .... **$664.88**
FX-80 .... **$564.88**
FX-100 .... **$769.88**

INFORUNNER

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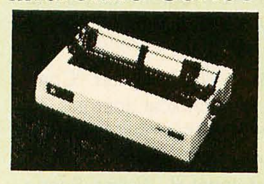
NEC

SpinWriter

2010/2030 .... **$999.88**
2050 .... **$1149.88**
3510/3530 .... **$1729.88**
3550 .... **$1999.88**
7710/7730 .... **$2399.88**

OKIDATA

Microline Series



Microline 80 .... **$339.88**
Microline 82A **$419.88**
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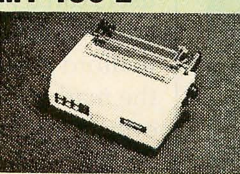
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Microline 84 .... **$1024.88**
w/RS-232C **$1124.88**

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MT-160 L **$689.88**
MT-180 L .... **$CALL**
MT-Spirit .... **$CALL**

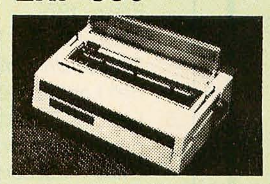
SMITH CORONA

TP-1/TP-2

TP-1 .... **$CALL**
TP-2 .... **$CALL**

SILVER REED

EXP-550

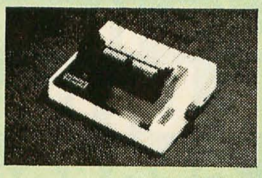


The **EXP-550** features 17 cps, 10/12/15 pitch capability, Diablo code compatability. An exceptional printer.

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w/(RS-232C) **$759.88**
EXP-500 (Parallel) **$459.88**

STAR MICRONICS

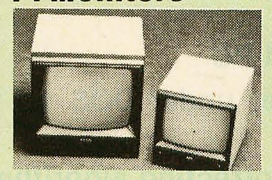
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Delta 10 .... **$CALL**

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DC HAYES

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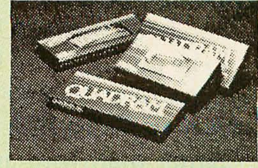
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1200 .... **$539.88**
1200B w/Smartcom II (IBM PC) **$459.88**

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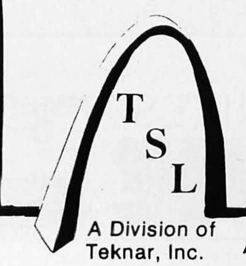
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no previous computer experience, one book teaches editing and formatting in about eight hours. *The Unix Tutorial* by Peter Birns, Pat Brown, and John Muster (UC Berkeley, 1983, to be published by Prentice-Hall late this year as *Unix for People*) starts with the vi screen editor, as is appropriate, rather than with an outmoded line editor such as ed or ex.

For those interested in learning all the facets of Unix, rather than merely document preparation, *Introducing the Unix System* by Henry McGilton and Rachel Morgan (McGraw-Hill, 1983) is a clear but detailed book that includes several chapters on the various editors and formatting tools. It is so good that it is unlikely to be superseded. The System V Unix release from AT&T includes a new guide to document preparation. Unfortunately, like most of the new documentation from Western Electric, this guide adds more paper to the stack of Unix manuals—but little functionality. It is hard to use this book, and the text is often lifted verbatim from material available elsewhere. Consult the books listed in the references list at the end of this article for more on the Unix formatting and typesetting system.

But realize that by the time a software system is as mature, reliable, and well documented as troff is, it is already outmoded. Anybody who has thought seriously about troff will tell you that someone should write a better formatting and typesetting system. Such a system would provide interactive previewing on a bit-map display, the capability of incorporating pictures and graphs within a document, and a simple icon-oriented user interface. Of course, those people never volunteer to write this system themselves, nor do they offer to pay for the years of labor required to carry out such a project. Until a better system is developed, users can try some of the sophisticated Unix-based systems, such as the Bedford system, that are already on the market. Those alternatives, however, are very expensive.■



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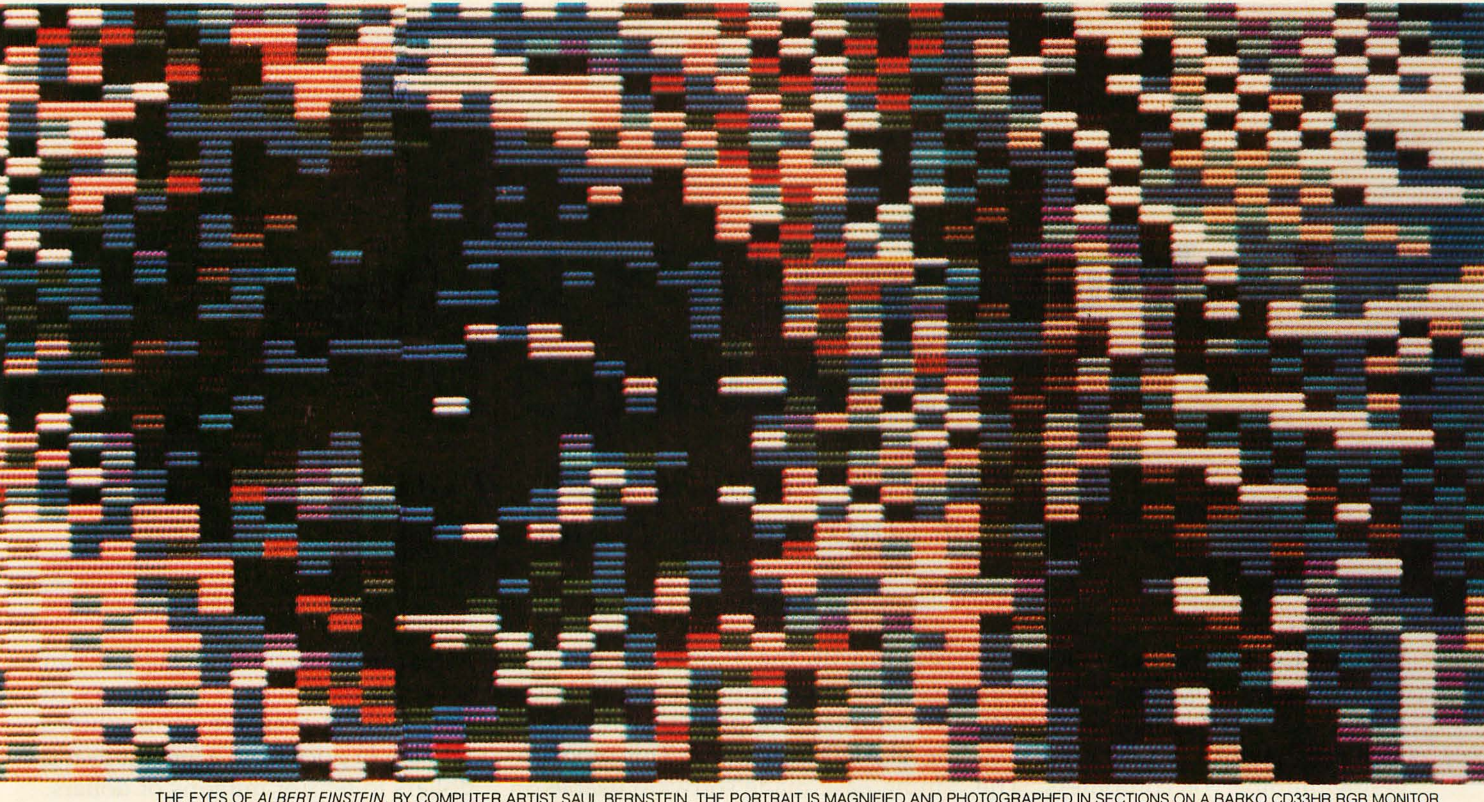


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Calendar Clock	50	Included
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Integrated Software:		
Financial Forecast		
Word Processor		
Data Base Manager		
Mailing List		
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	3385	1645

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Moving Unix to New Machines

Some portability considerations and a case history of Unix for the NS16032

by Michael Tilson

Noted for its power and elegance, the Unix operating system is highly portable. As a result, largely compatible versions of Unix exist on a staggering number of computers. The task of moving ("porting," in Unix jargon) the operating system to a new machine, however, can prove challenging, as we will see.

Software History

Before we look at a case study, consider the trends that have influenced software development and the features that make Unix portable. A major development in the history of software has been the movement away from machine-specific (nonportable) code toward machine-independent (portable) code. The earliest computers were programmed in machine language, and the resulting programs would run only on a specific type of machine.

Later, high-level languages made it possible for programs to be written more quickly; these languages could directly express high-level concepts, freeing programmers from having to deal with many machine-level details. The high-level concept of addition, for example, is independent of the machinery that performs the calculation, and high-level languages that directly express the idea of addition with the + operator can free programmers from having to know the format of a particular machine-level ADD instruction. This programming ease made software usable on more than one type of machine when high-level languages were implemented on new machine environments.

Although languages quickly achieved a high degree of computational portability, things were not as easy when it came to noncomputational tasks. The operating-system environments in which the high-level programs ran were very different from one machine type to the next. Although the ability to open, read, and write files is as important in real-world applications as computation, each operating system had a different way of performing these basic functions as well as a different command syntax and a different set of utility programs for editing or file maintenance. Moreover, most operating systems required that the programmer deal with machine details (such as disk-track size) that were unimportant from an applications standpoint.

Unix Portability Advantages

In an attempt to overcome these drawbacks, Unix was designed to be portable. Because the Unix system hides most machine details, it can serve a broad range of computers. In fact, Unix is available on machines ranging in price from a few thousand dollars to tens of millions of dollars. No other system has the same degree of portability (see table 1).

Portability, in this case, means that software developed for Unix can run without change on almost every available computer (if that computer is running Unix). Programmers also benefit from this portability. For example, a programmer using a 16-bit microcomputer version of Unix can make use of the full set of Unix utilities, and if he or she moves to an Amdahl mainframe, the same programming environment can be used. The same commands are used to copy or remove files or to compile C programs. A few details may be different, but the programmer needn't relearn everything.

Other operating systems take other approaches to portability. The original CP/M, for example, was portable in the sense that binary 8080 programs could be insulated from the details of device support. Because the 8080 (and Z80) was dominant in the early personal computer market, programs that used CP/M could run on many machines. However, most CP/M programs were written in 8080

assembly language, so moving these programs to new processors such as the 68000 is not easy. CP/M is also unable to provide some services needed by larger systems, such as multiprocess and multiuser support or a standard high-level implementation language. Thus, it does not span the range of machines Unix does. It is hard to imagine, for instance, the CP/M system in control of an IBM mainframe.

Another approach to portability that has achieved wide acceptance is the UCSD p-System. P-System programs are typically written in Pascal. Like Unix, the p-System provides an entire operating environment. Because the p-System is interpretive, it is possible to write binary programs that can run on any p-System machine, making p-System applications highly portable. Unfortunately, the interpretation is inefficient. And, as with CP/M, the p-System environment lacks multiprocess and multiuser support and does not comfortably scale up to larger configurations.



Photo 1: *The NS16000 workstation, which includes memory-management and floating-point capabilities. This workstation was used to port a demand-paging virtual-memory implementation of Unix to the NS16032 processor.*

Another portability approach makes use of a "layer" of software. The layer's function is to hide the ugly details of the operating systems. The most widely known example of this is the Software Tools package, which provides a virtual operating system. With it, programs are written in highly portable FORTRAN (using a preprocessor to translate an enhanced language into standard FORTRAN). All operating-system functions are performed using only a standard set of library routines. Thus, all that is required to move a program is standard FORTRAN and the necessary library.

Now consider the Unix system. It is portable at the source-code level; therefore, if an applications program is written in the C language using standard Unix system calls, that program should be portable to any Unix environment. The Unix system comes with a complete set of utility programs, so that large applications can be constructed using standard tools that function in the same way on all machines. The system has enough power to be used on large machines as well as microcomputers.

What Makes Unix Portable?

To understand the portability of Unix, we must look at the steps involved in porting Unix. How does one get Unix on a new machine? There are three components: a C compiler, the Unix kernel, and the Unix utilities.

The Unix system is written almost entirely in the C *high-level* systems-

Altos	Ithaca Intersystems
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IBM	Wicat
ICL	Zentec
Intel	Zilog

Table 1: *A partial list of manufacturers whose computers can run Unix.*

implementation language. C is similar to Pascal, although C has a more abbreviated syntax, greater expressive power, and offers much more freedom to access low-level machine resources. The use of C is pervasive throughout the Unix code for both the system proper and the utility programs. Thus, a reliable C compiler is a prerequisite for porting Unix to a new machine. The portable C compiler is an important part of the Unix system. This compiler is designed to be adaptable to new machines.

The Unix system, which consists of approximately 200 programs, is structured in two levels: the kernel level and the user level. The kernel has full control of the machine resources, while user-level code has no direct access to any resource. The kernel is responsible for process management, I/O (input/output) support, and file-system management. All resource usage (for example, process creation, file creation, or file I/O) is accomplished by system calls to the kernel. There are about 40 important system calls. Over the years, additional features have been added to the Unix kernel. These features are frills—the basic 40 system calls support 99 percent of the applications programs.

These system calls are machine independent to enhance Unix's portability. For example, the write system call writes an arbitrary number of bytes to a file at an arbitrary byte position. The parameters do not depend in any way on disk-track sizes or other hardware features. In fact, one can write to a file, a tape, or a line printer in exactly the same way. Most aspects of the file-system, process-management, and process-scheduling functions are also machine-independent.

The kernel interface is narrow and powerful. A small set of primitives provides the necessary services in a way that does not depend on the features of the underlying hardware. This hardware independence stems from the original Unix system's design, which was based on a simple but high-level notion of operating-system service; this concept is akin to the idea of providing the + operator in a high-level language rather than using machine-level ADD instructions. Although the first versions of Unix were not portable (in fact, the earliest Unix system was written in assembly language), the high-level concepts involved are inherently portable. The "ideas" of addition and file I/O are the same on all machines.

The Unix kernel, which is mostly machine-independent and written almost entirely in C, consists of less than 20,000 lines of code. Roughly 1000 of these lines are low-level assembly-language support routines. Around 4000 lines are devoted to device, memory-management, and process support. If these 1000-line and 4000-line sections are rewritten, the kernel should run on a new machine.

The remainder of the Unix system (the kernel represents only a fraction of the total code) consists of machine-independent user-level code—even the Unix command interpreter is just an ordinary user-level C program that needs no special machine-dependent privileges at the hardware level. Therefore, to implement Unix on a new machine, you need only build a C compiler and implement the Unix kernel. In theory, everything else comes easily. In practice, it isn't that simple.

The Challenge of Porting Unix

One consideration in the implementation of Unix is its demand on hardware—Unix needs more hardware facilities than either CP/M or the p-System. For example, because Unix is a true multiuser, multiprocess operating system, it usually requires memory management and protection. Memory management enables the system to allocate processes to any free area of memory, and memory protection prevents one program from destroying the code or data of another program that may be running simultaneously. Memory protection is also used to enforce the narrow and well-defined interface between the user level and the kernel level.

Unix systems are oriented toward disk access. Users can request large amounts of work from the system (this means less work for people and

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more work for machines). As a result, the system makes heavy use of the disk for program loading and file I/O. The design of the system revolves around the file system; therefore, it is not reasonable to run the system without a hard disk. Finally, most Unix configurations require at least 256K bytes of semiconductor main memory.

Although Unix is a powerful system, it can't run on all computers—the hardware must have a certain level of sophistication. An IBM Personal Computer with a hard disk probably represents the minimum configuration. Although the IBM PC, based on the 8088 processor, lacks memory protection, it can run Unix because it is a single-user machine and needs less memory protection than a multiuser system would.

Portability Problems

Given the right hardware, it seems easy to implement Unix. However, Unix is not perfect, and various problems will arise. For example, many Unix utilities make unfortunate assumptions about the underlying machine. It is usually easy to compensate for these assumptions on a machine for which they are false, but it can take some time to test all 200 Unix programs to discover any portability problems.

Ironically, some portability problems arise from features built into the C language, which was chosen in part to enhance Unix's portability. The C language is about twice as extensive as Pascal, mainly because many low-level features (such as arithmetic on pointers) have been included in the language to allow machine-independent programming. For example, if a C command increments a pointer by one, the pointer points to the location of the next data item in memory, not to the location of the next byte. (The latter result would typically occur in response to a hardware-dependent pointer-increment command.) Thus, with the C implementation, adding one to a pointer that points to a *double-precision* number yields a pointer to the next double-precision number; this operation has the same meaning on all machines running C.

Unfortunately (at least from the standpoint of portability), however, some machine-dependent operations are also allowed in C. For example, C allows you to treat a pointer as an integer and to perform bit-masking tests on the value of that pointer. Although this capability can be useful for implementing functions such as storage managers, the capability is inherently nonportable because some machines store pointers simply as byte numbers while others use more complex schemes. If a program knows that a certain bit in a pointer indicates a certain fact, then the program can successfully run only on machines for which that bit indicates the same fact.

Another difficulty encountered in porting Unix is implementing the C compiler. On some machines, implementation is not difficult, but because the language is large and subtle, eliminating all of the bugs is never a trivial task. On other machines, construction of the compiler can be a formidable undertaking. For example, the "character" is a C data type, and the C language requires pointers to character (i.e., byte) locations. But some machines are word-addressed—their natural machine pointer can only refer to an entire 16- or 32-bit word, and the compiler may have to resort to extreme measures to provide the necessary byte pointers. At Human Computing Resources (HCR) our implementation team has implemented compilers for two such machines and has found the task difficult.

The C language is based on a simple model of the underlying hardware; some more complicated machines have been designed specifically for other languages such as Pascal. The implementation of a C compiler on single-language machines often requires ingenuity because all of those "good" machine features turn into obstacles that must be circumvented, subverted, or otherwise overcome. (For example, C and Pascal subroutine calling conventions are quite different. If a machine is designed specifically for the Pascal convention, implementation of the C convention may be difficult.) At HCR we did it once, and we can testify that it isn't easy.

Once a C compiler is implemented, it is necessary to implement the kernel. Again, some machines fit well with Unix, while other machines have features that must be overcome. The closer the fit, the shorter the implementation time required.

Other problems are not so obvious. For instance, a machine may have used its own proprietary operating system for years, and the programs that drive its various peripheral devices (often written in assembly language) have been passed down from one generation of programmers to the next. In some cases, nobody has looked at the hardware manuals for years. Unix is a whole new system. The implementation team must sit down with the manuals and write the kernel hardware-support routines. Because the kernel is written in a high-level language, it will probably use all of the available hardware features. In fact, Unix is known for driving machines harder than any other system. When implementing Unix, programmers often find that the manuals are incorrect or incomplete or that some hardware feature has never before been used and doesn't work. This can wreak havoc with implementation schedules.

New machines have similar problems. The documentation may be incomplete or wrong. The machines may have design errors. Again, these errors are often not apparent in testing but show up under the load of a Unix system. Prototype machines especially tend to have reliability problems. Most programmers never expected to have to learn how to use a logic analyzer and often find tracking down subtle hardware errors a frustrating experience. At HCR, we often experience this problem because our implementation team usually uses prototype machines a year or more before they reach the public.

A Case Study: the NS16032

This case study provides some insight into the process of porting Unix. In mid-1982, we began work on our Unity version of Unix for the Na-

tional Semiconductor 16032. (This work resulted in a public demonstration at the November 1982 Comdex show. That demonstration was the first public exhibit of a true demand-paged, virtual-memory implementation of Unix on a microprocessor.)

The National 16000 series is probably the most suitable chip set available for Unix. It has a 32-bit software architecture, so there are no unnecessary memory-addressing limits. The instruction set has been designed to support high-level languages. Architecturally similar to the DEC VAX superminicomputer, the 16032 has some additional features. Full memory management is provided with a standard chip, including demand paging, which allows virtual memory to be supported. A floating-point chip provides a true floating-point instruction set; the NS16032 does not rely on the cumbersome coprocessor scheme used by some other machines. Although the details and actual instructions are different, the machine may be described as a "VAX on a chip." Because the standard Bell Laboratory release of Unix ran on the VAX, we expected this implementation to be easier than others.

The basic process of a "Unix port" is simple, but there are many complicated details. The first step involves becoming familiar with the target machine. In my company's case, we took delivery of a prototype workstation from National Semiconductor (see photo 1). This station had all of the necessary equipment but no software except for some bootstrap ROMs and some diagnostics. All initial software development took place on a VAX 780 running Unix. (It is conceivable that one could port Unix without a nearby Unix development system, but it would be needlessly difficult.) A period of reading and experimenting ensued.

When doing work of this sort, it's always a good idea to start with similar software and modify it. We used the portable C compiler for the VAX and converted it into a 16000 compiler. A skeleton of the 16000 compiler already existed. Implementation of the compiler proper posed no great technical problems. We did have to make a significant design tradeoff: the 16000 architecture allows global data and procedures to be directly addressed, or you can access data and code via the "module table." The latter procedure is a bit slower but results in smaller code because a user might often be able to use 8-bit offsets into the module table rather than full 32-bit address constants. We decided to use the module table because there are many benefits to having smaller code. Smaller code reduces program loading time and reduces the virtual-memory paging rate. The VAX does not have an equivalent feature.

The portable C compiler generates symbolic assembly code. That code is then assembled, and the resulting object module is linked with other modules and library routines.

The idea of porting Unix is simple; the implementation can become complicated.

The second step in porting Unix was construction of an assembler and linker. The main difficulties here involved the large variety of addressing modes and the correspondingly complicated program-relocation information needed by the linker. The module table added significant complexity. The assembler and linker probably involved as much work as the compiler.

Having "finished" the compiler/assembler/linker, we had to test the result. We developed down-line loading software so that we could compile programs on the VAX and run them on the National machine. We then started to test the compiler. During previous projects (HCR has ported Unix to a number of machines, including the MC68000, the Computer Automation 4/95, and the Three Rivers PERQ), HCR had developed an extensive test suite for the C compiler. This test suite requires minimal hardware support—only the ability to print characters. The test suite is not perfect, but it does check out a large fraction of the compiler. On the National machine, the compiler stabilized quickly. Because the machine architecture is very regular, there are not a large number of special cases, which are often a source of compiler bugs.

In parallel with the compiler effort, we began work on the kernel. The first requirements were for a bootstrap loader, a low-level machine assist, some software to handle communication with the host development machine, and driver software for the disk unit. When these were met, we ran our first stand-alone programs. These stand-alone programs were some of the basic Unix maintenance programs, modified to call a library of stand-alone routines rather than the (as yet nonexistent) operating system. The programs were used for initial setup, such as construction of an empty file system on the disk or loading of files into the file system. This stage also checked out the team's fundamental understanding of the hardware.

The kernel was the next big step. We adapted a VAX version of Unix to run with the National hardware. As expected, most of the code ran unchanged. It was especially helpful that the memory-management scheme closely resembles that of the VAX. We used the demand-paging code from the Berkeley version of Unix. That code was far from perfect, but it did work, and it gave us a starting point. The initial kernel had a number of loose ends, but it was solid enough to start loading processes. We have an initial kernel test process that verifies that basic functions work correctly.

Once the initial kernel had come up, we were ready to finish the job. We started cross-compiling the utility programs, starting with the most important. (The utility that rebuilds damaged file systems is quite useful at this point because the system is still likely to crash from time to time.) At the same time, we finished off loose ends in the kernel. Moving utility programs was easy because the 16000 architecture is so similar to that of the VAX. In fact, it is hard for a C program to know that the

machine is not a VAX. This is in stark contrast to other machines in our experience. The major task was to verify that all of the utilities are operational. Again we employed a test suite. As a result we found a few more compiler bugs and one or two kernel bugs.

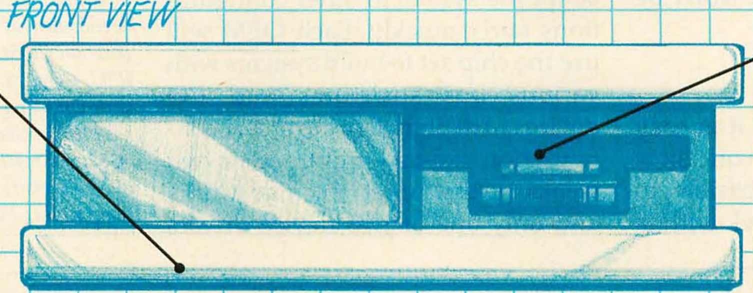
Some other programs require adaptation to the specific machine (for example, the FORTRAN compiler). We also added a few extra system features, such as bitmap display support.

Moving C programs to the 16032 was easy because the 16000 architecture is similar to that of the VAX.

All of this sounds too easy. In fact, we did encounter some difficulties. Nearly all of the problems stemmed from the fact that we were using prototype hardware with engineering sample chips. At one time or another, everything that could go wrong did. There were errors in the documentation. The disk did not work. The disk controller did not work. The central processor board did not work. The central processor chip did not work. The memory-management chip did not work. The interrupt controller did not work. The floating-point chip did not exist at first and then did not work. The problems were usually intermittent, often subtle, and always maddening.

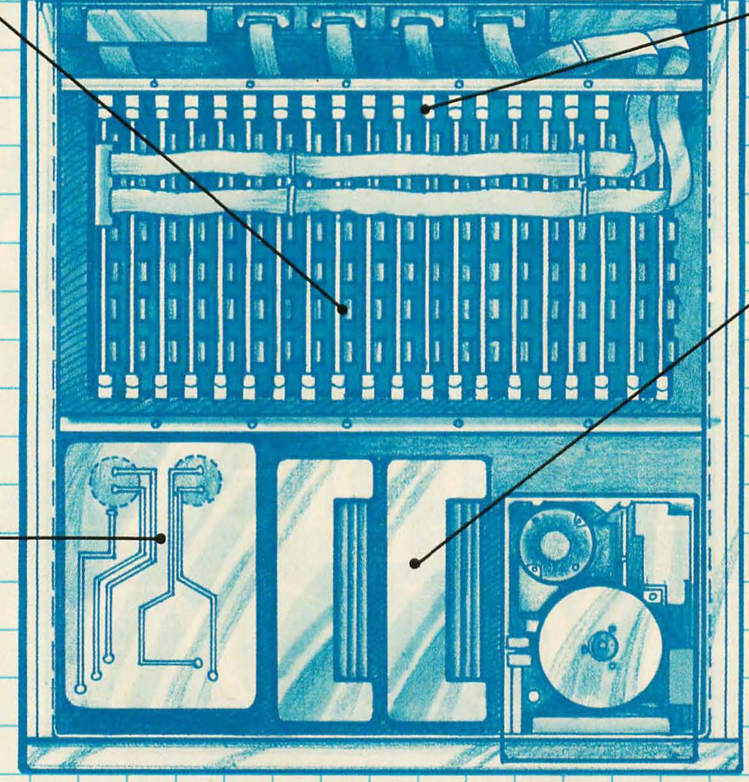
(Important note: it would be false to conclude that the National chips or hardware are unreliable; these problems always occur with new chips or prototype hardware. Before parts reach production quality, they exist in experimental form. National provided good support during the project and the problems have been solved. We have since then had excellent success in making our product run on original equipment manufacturer (OEM) machines using the 16032 processor. Because chip-development cycles are long, we

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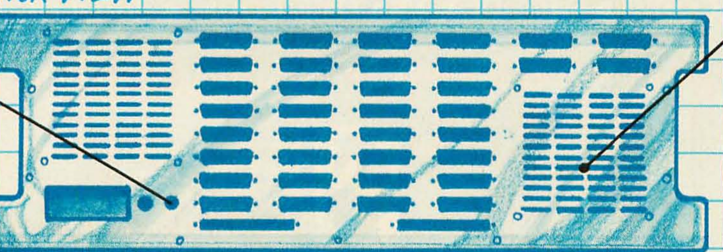
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often had to patch around the problems to continue work. We were only able to demonstrate at Comdex because of the quality, dedication, and perseverance of the implementation team. This kind of debugging requires a high level of expertise. Having to do this debugging is the penalty you pay for being on the leading edge—if you wait for the final production hardware, you won't be first.)

Finishing the Job

Many people think that it is easy to bring up the Unix system on a new machine. In fact, it is possible to bring up a limping kernel with a buggy compiler in about four months. However, to bring up a system with all of the utilities, with an allowance for inevitable problems, with some performance tuning and commercial enhancements, and with everything tested and solid, takes about a year. Once Unix has been ported to a particular hardware type (e.g., the 16032 chip set), you can adapt the system to other configurations fairly quickly. Each OEM will use the chip set to build systems with various bus structures and I/O devices. Adapting Unix to a new configuration can take from one or two weeks (if the target machine works and only one or two device drivers are required) to several months (if the hardware doesn't work or is otherwise intractable, or if "strange" devices must be supported). Some people also refer to this configuration process as "porting" Unix, but the final process of adaptation to OEM requirements is not nearly so difficult.■

Michael Tilson is vice-president for technical development at Human Computing Resources Corporation (10 St. Mary St., Toronto, Ontario M4Y 1P9, Canada). He has many years of experience with Unix and Unix-based software products. He has been involved with the implementation of Unix on several machines and is actively involved with industry efforts to increase the level of standardization of Unix-like systems.

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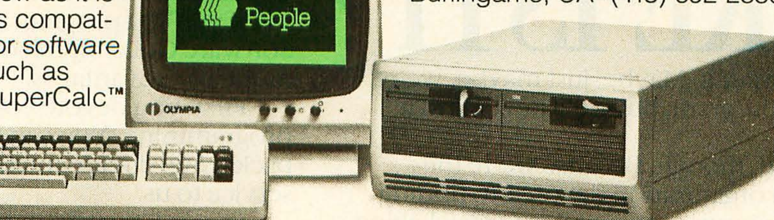
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The NEC Advanced Personal Computer

High-resolution graphics, color, and 16-bit performance in an attractive package

by David B. Suits

Not long ago, I started looking for a new microcomputer. Actually, I wasn't looking so much as musing about which computer would be a significant step up from my 8080-based system. My next computer, I knew, would have a 16-bit CPU (central processing unit). It would use Digital Research's CP/M-86, have a high-resolution color-graphics display, and come with dual 8-inch disk drives. The drives would be arranged so that the disks could be inserted vertically. (Perhaps I have strange wrist bones, but I find it uncomfortable to have to load disks horizontally.) I also wanted a detachable keyboard with four cursor-control keys arranged in a diamond-shaped pattern. The keyboard would have to have a separate calculator-style keypad for easy entry of numeric data and some special-function keys to make application programs (such as word processors) easier.

Nothing advertised in the magazines met my requirements. I thought I would have to start making some compromises.

The APC

Perhaps NECIS (NEC Information Systems) read my mind. Its APC (Advanced Personal Computer) fulfilled my expectations (see photo 1) and, in fact, exceeded them. The NEC APC also has double-sided double-density disk drives; the keyboard has 22 programmable function keys; there is a user-definable character set; and the system includes a real-time calendar/clock, a single-voice music generator, 128K bytes of RAM (random-access read/write memory), and 4K bytes of battery-powered RAM that will retain data even when the computer is off (see At a Glance box on page 284). There is also an automatic power-off feature so the machine can be turned off under software control.

The APC is available in a monochrome or color model. The monochrome model comes with one disk drive; two drives are optional. The color model comes with two integrated drives. The disk-controller chip, the NEC 765, handles up to four single- or double-density floppy-disk drives. Having "grown up" with single-density 5¼-inch disks, I was impressed by the new double-density 8-inch disks. The formatted capacity of each disk is 1 megabyte, and data is transferred via DMA (direct memory access) at 62.5K bytes per second.

The APC Display

The 12-inch CRT (cathode-ray tube) display is handled by NEC's 7220 GDC (Graphics Display Controller), a complex and powerful chip that can control up to 256K 16-bit words of display memory, partition the display into four text or graphics areas, and perform figure drawing, area fill, panning, and zooming. The APC display refresh memory (without the optional graphics subsystem installed) consists of 12K bytes of static RAM separate from the 8086 microprocessor's main memory.

The screen has 25 lines of 80 characters each, with a 26th line, or status line, at the top (see photo 2). The status line shows a digital calendar/clock, indicates which



Photo 1: *The NEC APC (color model), with five volumes of documentation. The main power switch is under the display. The brightness and volume controls are under the disk drives. Note the main power cord, which attaches to the front of the system.*

of four latching-switch keys is down (Caps Lock, Grph1, Grph2, and Alt), and shows what NECIS calls the "speed," a number from 0 to 9 that indicates the relative speed with which characters are output to the screen. (The speed is user-determinable from the keyboard, but it is not clear where its usefulness lies.)

Each of the character positions on the screen is composed from a matrix 8 pixels wide by 19 pixels high. While some APC special characters use the entire width or height of the matrix, the ASCII (American National Standard Code for Information Interchange) characters are displayed in an 8 by 13 subarea, and the user-defined characters are formed in an 8 by 16 subarea.

The 8 by 19 character box and the 25-line by 80-character screen give the screen a resolution of 640 pixels horizontally by 475 pixels vertically. However, the status line at the top of the screen also occupies display memory, so the actual vertical resolution is 494 pixels. NECIS's CBIOS (customized basic input/output system) routines that come with CP/M-86 allow for turning the status line on and off but not for moving the cursor into that line. To make use of the full 26 display lines, I had to write a custom routine to handle the GDC. The documentation supplied with the APC is extensive but seemed complex. After I understood the basics of the GDC, however, I found that it was relatively simple to get it to do what I wanted in the way of cursor, character, and attribute manipulation. The powerful graphics features of the GDC are a bit more difficult to manage, and I have only recently begun to tackle them.

Any display character may have six attributes: overline, underline, vertical strike through, reverse video, blink, and color. The overlines, underlines, and vertical lines always appear in steady green, even if the character appears in some other color or is blinking.

There are eight screen colors available: black, red, blue, purple, green, yellow, light blue, and white (see photo 2). (I prefer "magenta" to "purple" and "cyan" to "light blue," but NECIS uses the less esoteric names. On the other hand, NECIS refers to black as "secret.") In the monochrome version only black, green, and "highlight" (bright green) are available as color attributes. When the "reverse" attribute bit is set, the selected color appears as the background for the character, and the character itself is black. (I wish there were a way to select foreground and background colors on the color model so characters could appear in any of the eight colors against any of eight background colors. But that would require

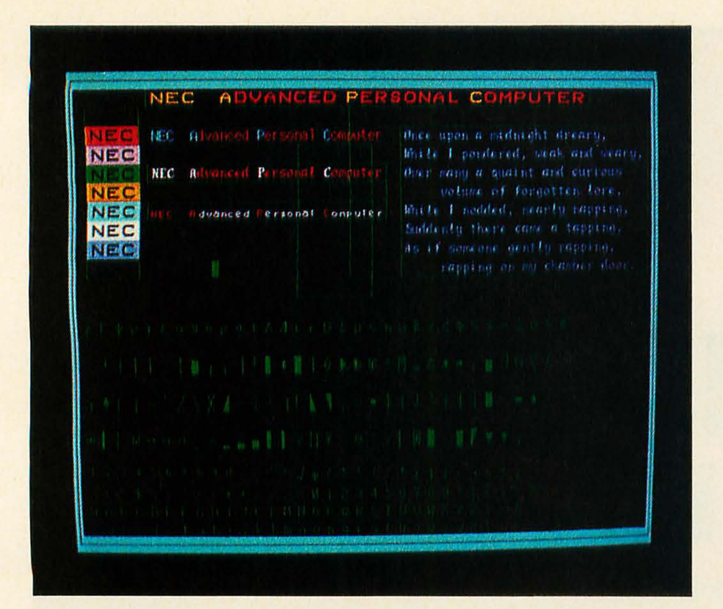


Photo 2: *The APC display, showing normal ASCII characters, special characters, and user-defined characters. Eight colors are available (in normal and reverse video), plus underline, overline, vertical line, and blink.*

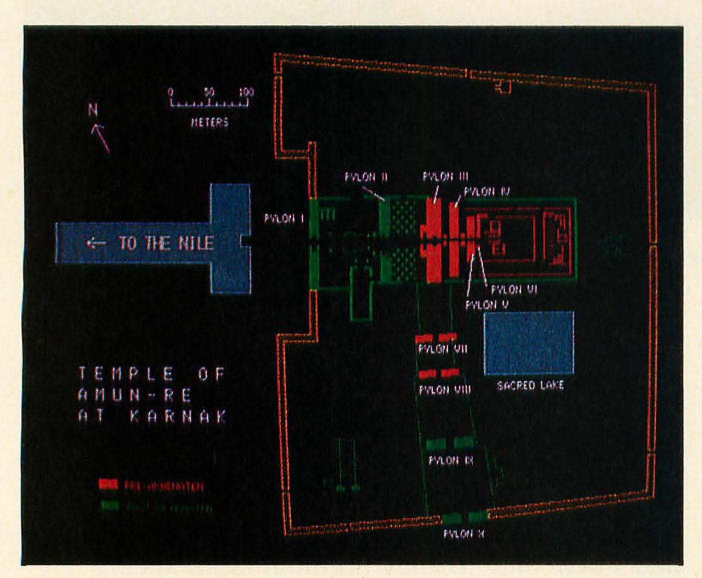


Photo 3: *Examples of color graphics on the APC. Although each pixel may be only one of eight colors, different colored pixels that are close to each other appear as new hues or shades.*



Photo 4: *The APC keyboard. Twenty-two programmable function keys are above the regular keys. At the top of the keyboard is an overlay strip that can be used to indicate the programmed functions of the special keys. Notice that the left Shift key is upside down (see text).*

that each character's attribute be extended by three bits.) The attribute for each character is set independently of the attribute for any other character.

NECIS offers an optional graphics subsystem board for the APC that consists of a second 7220 GDC and enough memory to specify the color for each pixel in a 1024 by 1024 array. (The actual screen display, however, is a 640 by 494 movable "window" into that larger area.) For the monochrome model, 128K bytes of RAM are added; for the color model, the graphics board contains 384K bytes.

The second GDC runs independently of the first, and the outputs of each are combined and sent to the screen. This means not only that text and high-resolution graphics may be displayed simultaneously, but also that they are manipulated independently of each other (like two transparent display planes, one on top of the other).

The color graphics are impressive and fast (see photo 3). The GDC chip is capable of a wide variety of figure drawing with area fill (including many kinds of patterns), panning, and zooming.

The Keyboard

The APC keyboard is detached from the main enclosure and sports 108 keys; 22 are user-programmable function keys on the top of the keyboard (see photo 4). The KEY utility program provided on disk allows the user to program only the first 16 of these keys; the remaining six keys are "reserved," although no definite use is claimed for them anywhere in the documentation. They are programmable, but you would have to dip into the CBIOS routines to program them. To the left of these function keys is a key labeled FNC, which acts as a shift key, giving each of the 22 function keys a second function (also programmable).

In addition to the alphanumeric and programmable function keys, there are, on either side of the space bar, four new keys: Grph1, Grph2, Alt, and Help. The Grph1 and Grph2 keys access the APC's special characters (Greek letters, mathematic symbols, and character graphics). The Alt key is supposed to allow access to the user-defined character set, but it does not. (I had to write my own assembly-language routine to access this set. In the process I discovered that the APC's CBIOS routines could have easily allowed the Alt key to access the user-defined characters, but, for some reason, did not. I suspect that it was a mistake that might be remedied with one or two additional instructions in the code.) The Help key ordinarily echoes as a question mark, but application programmers may reprogram it to present help messages.

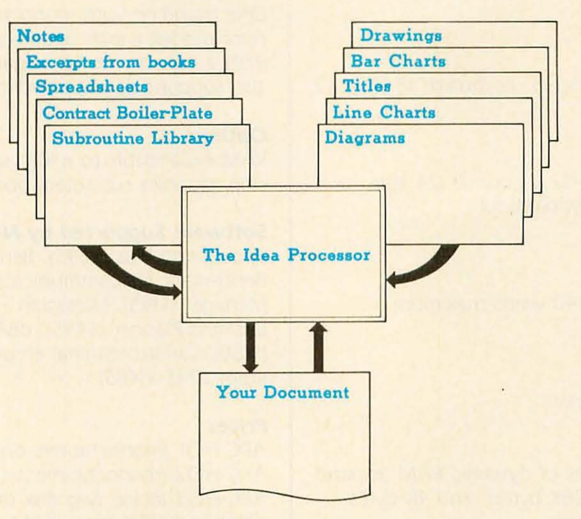
Separate from the main set of keys is a 25-key cluster including a numeric keypad, a Delete key, an Insert key, a Clear/Home key, a Print key, a Break/Stop key, and four cursor-control keys. The CP/M-86 utility programs recognize the Break/Stop key as a Pause key (Control-S); pressing it once causes processing to stop and pressing it a second time causes processing to continue. Pressing Shift along with the Break/Stop key generates Con-

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At a Glance

Name
NEC APC (Advanced Personal Computer)

Manufacturer
NEC Information Systems
5 Militia Dr.
Lexington, MA 02173
(617) 862-3120

(NEC Information Systems should not be confused with NEC Home Electronics, distributors of the PC-8000 microcomputer, although both organizations are divisions of Nippon Electric Company, Ltd.)

Dimensions
Main enclosure: 18.5 by 13.8 by 18.1 inches; keyboard: 18.9 by 2.2 by 8.5 inches

Weight
Main enclosure: monochrome model—52.8 pounds (24 kg); color model—74.8 pounds (34 kg); keyboard: 5.1 pounds (2.3 kg)

Power Requirements
105 volts to 130VAC, 50/60 Hz; 150–340 watts maximum (without options)

Processor
5-MHz NEC PD8086 16-bit microprocessor

Memory
4K bytes of bootstrap ROM, 128K bytes of dynamic RAM (expandable to 640K bytes in increments of 128K bytes), and 4K bytes CMOS RAM with battery backup power

Standard Configuration
Main unit with integrated CRT display, integrated disk drive(s) and five-slot card cage, parallel-printer interface, RS-232C synchronous or asynchronous serial interface, programmable music generator with speaker, hardware calendar/clock, 108-key keyboard

Video Display
12-inch diagonal CRT with long-persistence phosphor, black/green/highlight (monochrome model) or eight colors (color model), 80 characters by 25 lines plus a 26th status line. Video resolution is 640 by 494 pixels with underline, overline, vertical line, reverse video, and blink. Character ROM has 224 characters with 256 user-definable characters. The video is controlled by a NEC 7220 Graphics Display Controller

Keyboard
Detached with 108 keys, including four cursor keys, a numeric keypad, and 22 dual-mode programmable function keys

Disk Drives
One (standard with monochrome model) or two (standard with color model) 8-inch double-sided double-density floppy-disk drives with a capacity of 1.2 megabytes each (single-density disks are also supported), integrated into the main enclosure

Options
RAM expandable to 640K, second serial interface, 8231 arithmetic chip, graphics subsystem board, hard disk, prototyping boards

Software Supported by NECIS
Accounting Plus ($695), Benchmark Word Processor ($495), Benchmark Telecommunicator ($95), Benchmark Mailing List Manager ($195), Microplan Financial Spreadsheet ($195), Microplan Business Planner ($495), dBASE II ($695), CP/M-86 ($150), MS-DOS ($150), various terminal emulator and communications packages (from $245-$1485)

Prices

APC-HO1 (monochrome, one disk drive)	$2748
APC-HO2 (monochrome, two disk drives)	$3448
APC-HO3 (color, two disk drives)	$4198
Additional 128K bytes RAM	$ 700
Each additional 128K bytes RAM	$ 200
Monochrome graphics subsystem	$ 448
Color graphics subsystem	$ 648
Arithmetic coprocessor chip	$ 250
Additional serial port (with cable)	$ 335
12-megabyte hard disk	$2698
Second hard disk	$2398
Engineering-development boards	$ 89

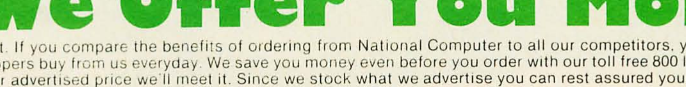
trol-C, which CP/M-86 interprets as an interrupt. Print is a convenient way to issue Control-P and causes data being sent to the screen to be sent to the printer as well. Pressing Print a second time turns off that function. Del acts as an "erase input line" key (Control-X). Ins, which issues character code 1C hexadecimal, is merely echoed as Control-backslash. Clear/Home sends the cursor to the top left corner of the screen; pressing it in conjunction with Shift will erase the screen.

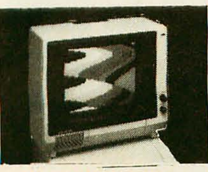
The four cursor-control keys are positioned in a diamond shape so that the up-arrow key is on top, the left-arrow key is on the left, etc.

There is a useful feature that enables the screen to act as a "window" into a 50-line display area at any given time. Using the Control key in conjunction with the up- or down-arrow keys causes the window to move up or down through the larger display area, so that up to 25 lines that have already scrolled up and off the screen can be easily displayed.

The keys have an excellent feel and sound. It is the fastest and most comfortable keyboard I have used, and typing on it is a joy (with one exception, which I'll mention later).

Inside the keyboard is an 8048 8-bit microprocessor that monitors the keys. When a key is pressed, the 8048 decodes it, sends an interrupt request to the 8086, and presents the key code to one of the 8086's ports. At the same time, the status of the switch keys (Shift, Control, etc.) is presented to another port. When the 8086 acknowledges the interrupt, a software routine reads the keyboard data into a 64-byte FIFO (first in, first out) buffer. This manner of handling the keyboard has two desirable consequences. First, it relieves the 8086 from having to interrupt what it is doing to poll the keyboard every so many milliseconds to see if a key is pressed; second, the 64-byte buffer acts as a type-ahead buffer so that if you type faster than the application program can process the input, no characters are likely to be lost.





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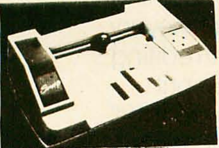
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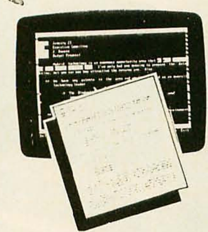
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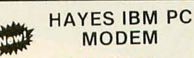
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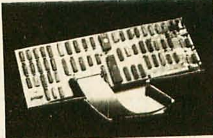
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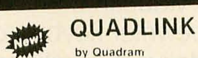
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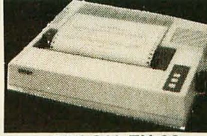


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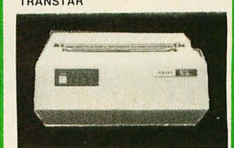
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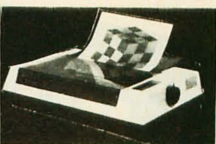


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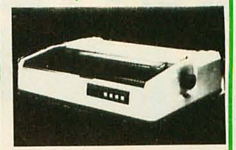
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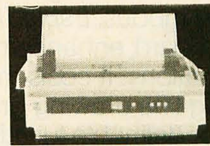
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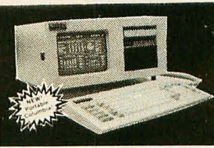
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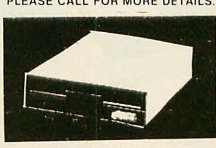
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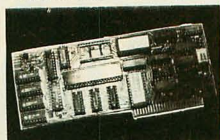
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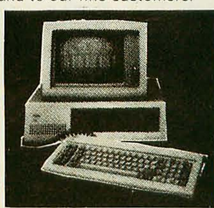
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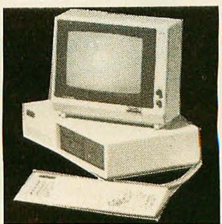
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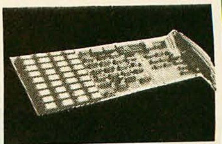
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Photo 5: *The APC nonmaskable interrupt switch. Access to the switch is possible only by removing a rubber plug in the rear of the keyboard.*

The keyboard has an undocumented feature. A close look reveals the absence of any CPU reset key. Nor does the main enclosure have such a switch. The only "panic button" evident is the main power switch, which is a poor substitute for a reset. There is nevertheless a hardware reset switch hidden inside the keyboard. (It took me several weeks to realize it was there.) Access to it is possible only by removing the rubber plug on the rear of the keyboard (see photo 5). You can stick a finger inside and press a momentary-contact switch that generates the 8086 nonmaskable interrupt. Unfortunately, unless you have inserted the proper jump vector into low memory, the 8086 jumps to a routine that prints "INTERRUPT TRAP HALT" on the screen and then stops dead in its tracks. The APC then has to be turned off and back on. I would have thought a warm or cold boot of CP/M-86 would have been more useful, but this is better than nothing.

Inside the Main Enclosure

One reason I was especially interested in the APC was because I had learned to associate NECIS with high-quality products. I was not disappointed.

On the outside, the APC has a clean and aesthetically pleasing design. A peek inside the main enclosure (see photo 6) reveals a thick steel chassis that reminds me of the tough insides of NEC's Spinwriter. The top cover securing latches, for example, could have been plastic, but instead they are ⅛-inch steel. The routing of all cables is neat and secure. There is nothing that hints of any last minute changes (except that the red, blue, and green bias pots on the analog board have been replaced by small shorting jumpers).

The two slim 8-inch disk drives to the right of the CRT are NEC's own (FD 1165 S). The six-slot card cage is occupied by three 100-contact circuit boards (not, alas, S-100). One board is the main processor board with the 8086 and 128K bytes of RAM. Another board contains the controllers for the CRT, disk drives, and serial and parallel interfaces, with an empty socket for an optional 8231 arithmetic coprocessor chip. (Rumor has it that NECIS may soon offer the 8087 chip instead.) The third board contains an additional 128K bytes of RAM and the second 7220 GDC with its own 384K bytes of RAM. Adding a second serial controller and the hard-disk controller would take up two more slots on the card cage, leaving only one. But the size of the boards (11 by 9½ inches) allows for a great deal of hardware on one board. You could, for example, get another 384K bytes of RAM (bringing it up to the maximum 640K allowed) on another board and still have room for something else. (A light pen would be nice.)

Documentation

The APC documentation is slick. Pages are typeset and arranged in two small three-ring binders. The *Operator's Guide* gives the user a brief overview of the system, unpacking instructions, etc. The *System Reference Guide* consists of several hundred pages of detailed descriptions of the APC hardware. I was amazed at the amount of information provided. There are even IC (integrated circuit) data sheets for the 8086 processor, the 7220 GDC, the 765 disk controller, and other important chips. (Not included are the data on the 8048 keyboard controller, the 8255A programmable peripheral interface, and the 1771 sound generator.) In addition, there are 22 pages of schematics. Even the PAL (Programmable Array Logic) decoding specifications are provided. Each manual has a table of contents, and the *System Reference Guide* has a glossary.

The CP/M-86 operating system has two other manuals: the *CP/M-86 System User's Guide* and the *CP/M-86 System Reference Guide*. They are typeset versions of Digital Research's manuals, with additions and caveats concerning the APC implementation and APC-specific features such as music generation, user-programmable charac-

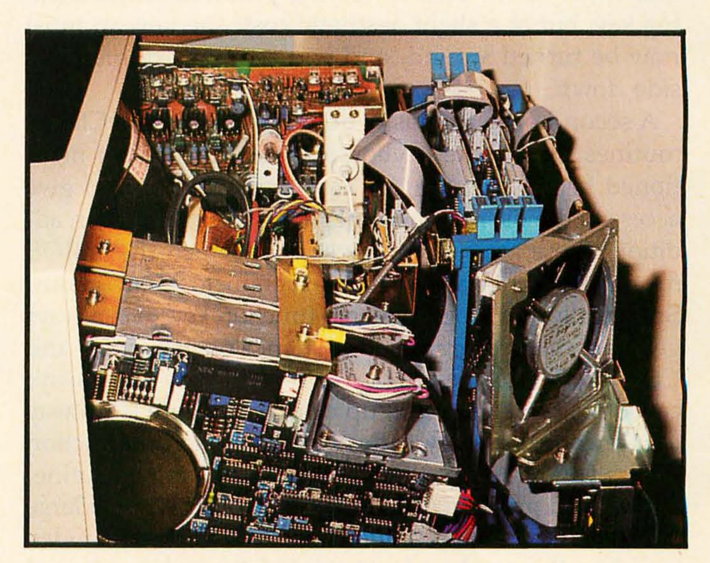


Photo 6: *Inside the APC (color model). At left are the two 8-inch disk drives. To the right is the ventilation fan. Behind the fan is the six-slot card cage, presently occupied by three boards. To the left of the card cage is the CRT, and behind that is the main analog board.*

ters, and so on. These manuals live up to Digital Research's strict requirements for near-completeness amid utter confusion. But a clever reader can often figure out some way to arrange a series of trial-and-error experiments on the computer to discover what the manuals were hinting at. Maybe.

In the text portions of the four manuals, I found only five typographical errors. The tables and drawings, however, were another matter. At last count there were 76 errors, most of them minor, but some of them the source of a great deal of confusion and wasted time.

An optional *Maintenance Guide* includes data not provided in the *System Reference Guide*, most notably a trouble-shooting guide, schematics for the analog board, and several pages of illustrated parts breakdowns. The trouble-shooting guide is interesting in that, if a faulty part is located, it instructs you to send the entire subsystem in for replacement. I suspect that this will make field maintenance of the APC a simple matter. Fortunately, my machine has been performing flawlessly from the time I first plugged it in, so I have had no occasion to seek maintenance.

Problems

The APC has some minor annoyances. I mentioned that the keyboard is excellent with one exception—the left Shift key. The key cap is about two and a half times wider than usual, which makes finding it with your little finger an easy matter. The cap attaches to the switch underneath by means of a shaft that comes down from the left edge of the cap. Unfortunately, a typist's fast-moving little finger often presses down near the center or the right edge of the cap. This applies torque to the shaft, which then binds—a real nuisance. Fortunately, the key can be unsoldered from the printed-circuit board underneath and moved over to the right (it's as though the keyboard was designed for the key to be soldered into either spot). This solves the problem of the sticking key, but at a slight aesthetic cost: the keycap must now be turned around, and you see Shift printed upside down.

A second problem has to do with the way the CBIOS routines handle the keyboard under CP/M-86. I mentioned before that the Alt key is not decoded to give access to the user-defined characters as it should. In addition, there are certain key strokes which the CBIOS routines will not allow your program to know about. Specifically, the programmable-function keys will always generate their programmed sequence of characters, and CONTROL plus the up- or down-arrow key will always cause the screen to scroll up or down. There is no way to intercept these key codes to take some other action unless you write your own keyboard-decoding routine.

The third problem concerns the display. When a large portion of the screen holds characters in reverse video (or when the graphics have printed over a large area of the screen), there is a flicker to the display. The display also wiggles slightly, although most people probably would not notice it.

Support

What kind of support is the APC owner likely to get from NECIS? Over the past four years I have occasionally dealt with NECIS for servicing of my (second-hand) Spinwriter printer. I have found the company consistently courteous, prompt, and helpful (over the phone, anyway). Although the printer is years out of warranty, they sent me, free of charge, an upgraded main processor board for it, along with a more recent users manual.

Although NECIS wants its APC customers to deal with their dealers and not directly with the head office, the head office seems to be bypassing its dealers and going directly to its customers. I was recently mailed an updated version of the CP/M-86 disk, but my dealer has not received a copy. (The updated version, by the way, provided for a 200 percent speed improvement in certain disk accesses and included Digital Research's GSX-86 graphics-system extension package which provides graphics handling routines allowing programs to talk to a number of graphics devices (CRTs, printers, plotters) in a uniform manner without having to worry about coordinate translations and scaling.)

Several months ago I received a letter from NECIS saying that some users felt the ventilating fan in the color model was too loud. (It is. The fan is a 4½-inch Sanyo that is noisy when the APC is positioned close to a wall that reflects the noise.) The letter said that users will be able to pick up smaller fans from their dealers and install them themselves. How much will this cost the user? Nothing. Moreover, NECIS does not even require the original fan in exchange. Unfortunately, my dealer was not told about these new fans, and even after several months he has still not been able to get any.

In spite of the lack of communication between NECIS's head office and the dealers, I believe that NECIS is taking a continued interest in customer satisfaction. The company distributes a number of software packages for the APC and each package is guaranteed to conform to the specifications supplied with it. (If it doesn't, NECIS will fix it or give you your money back.) Because the software includes database management, accounting, spreadsheet, word-processing, and communication packages, the company's guarantee is a significant indication of its support for the APC.

All of its software, however, must be run under the CP/M-86 operating system. Will NECIS support any high-level language or any other operating system? Yes and no. MS-DOS, the operating system from Microsoft that the IBM Personal Computer has made so popular, is now available for the APC. Getting a copy, however, has been so far impossible. I'll have to wait and see what happens. As for a high-level language from NECIS, there is PTOS BASIC, a BASIC interpreter provided only to dealers for running some graphics demonstration programs. Although no documentation is provided with PTOS BASIC, I did a little experimenting that revealed that it is similar to Microsoft BASIC with almost all the bells and whistles you could imagine and with some

Listing 1: *The Sieve of Eratosthenes Benchmark Program written in PTOS BASIC for the NEC APC.*

```
5 DEFINT A-Z
10 S=8190
20 DIM F(S)
30 PRINT "10 ITERATIONS"
40 FOR M=1 TO 10
50 C=0:FOR I=1 TO S:F(I)=1:NEXT
60 FOR I=1 TO S:IF F(I)=0 THEN 100
70 P=I+I+3:K=I+P
80 IF K < or = S THEN F(K)=0:K=K+P:GOTO 80
90 C=C+1
100 NEXT
110 NEXT
120 PRINT C" PRIMES"
```

powerful graphics commands. I hope NECIS chooses to release this BASIC.

To test the speed of the APC, I rewrote the Sieve of Eratosthenes program (see listing 1) in PTOS BASIC. Execution time (10 iterations): 1680 seconds. After removing line 5 (so that variables were single-precision floating point), execution time slowed to 2070 seconds. (The program was adapted from the BASIC version for the program listed in "Eratosthenes Revisited, Once More through the Sieve," January 1983 BYTE, page 283).

The APC is a member of the new generation of high-performance microcomputers. It will not compete in the low-end market dominated by Apple, Atari, Radio Shack, and Commodore. It does, however, represent an option to the IBM PC, but its success as a PC competitor will depend to a large extent on independent hardware and software vendors. There are already dozens of CP/M-86 programs—from business applications to languages to games—available from independent vendors that are written for, or can be customized for, the APC. The list is too long to include here (NECIS can provide about a 30-page list), but one item is worthy of note: Ticom (13470 Washington Blvd., Marina del Rey, CA 90291) has reportedly adapted the UCSD p-System for the APC and added support for the APC's graphics, music, and clock/calendar features. This opens a whole new range of application software.

It is by now a firm tradition that each brand of computer be supported by some kind of newsletter. An independent APC news journal, *NexWorld* (285 Beach St., Belmont, MA 02178), began publication in April. A slick (and a bit expensive) monthly publication, it is under the editorship of Kenneth T. Mazur.

Conclusion

When I set out on my search for a new-generation microcomputer, I had a checklist of desirable features. The APC fulfilled all my requirements and then some. I am pleased with its quality, design, and power. The high-resolution color graphics are impressive. The manuals supplied with the system contain a great deal of information about the machine's hardware. The problems I've encountered after six months of fairly intimate work with the APC can be classified as minor annoyances. On a scale of 1 to 10, I give the NEC APC a 9.■

I would like to thank the staff of the Computer Center of Rochester, New York, for their assistance in the preparation of this article.

David B. Suits, assistant professor of Philosophy at the Rochester Institute of Technology, is currently studying for an MS in Computer Science. He has written articles for other microcomputer publications, published the book Color Graphics for Intecolor 3651 and Compucolor II Computers, *and is coeditor of* Colorcue, *a newsletter for Compucolor and Intecolor computer users. He can be reached at the College of Liberal Arts, Rochester Institute of Technology, POB 9887, Rochester, NY 14623.*



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Circle 226 on inquiry card.



Photo 1: *The TRS-80 Model 4 may look like a Model III in a white cabinet, but it is really a new computer. (All photos by Glenn Mead.)*

Radio Shack's TRS-80 Model 4

This Model III-compatible computer has a host of new features and a lower price tag than its precursor

by Rowland Archer Jr.

The design of Radio Shack's new TRS-80 Model 4 computer is proof that large corporations can be responsive to the needs of their customers. An enhanced version of the popular TRS-80 Model III, its new features read like a Model III owner's wish list. Highlights include a 24-line by 80-column screen with normal and reverse video, an enhanced keyboard, a 4-MHz Z80A central processor, up to 128K bytes of RAM (random-access read/write memory), the ability to run normal CP/M, and an internal speaker for sound output. The Model 4 can also run any Model III software in a totally compatible mode. I tried hard, but I couldn't find a single piece of Model III software that didn't run perfectly on the Model 4.

Overview

The least expensive Model 4 is the $999 tape-based version. For $1699 you can get a Model 4 with one disk drive; most people will probably buy the two-drive system, priced at $1999. You can start with any model

and upgrade in stages all the way to the top of the line. Separately priced options include 64K bytes of memory for $149, the first disk drive for $649, the second disk drive for $240, and a 5-megabyte Winchester disk drive for $1999. There is an additional installation charge (not specified) for any upgrade. Radio Shack plans to offer a high-resolution (640 by 240 pixels) monochrome graphics plug-in card for $249.95.

If you own a Model III, you weren't forgotten. You can upgrade a Model III to a Model 4 for $799. This may seem expensive, but the upgrade includes a completely new main circuit board and keyboard, lets you run all your old software, and gets you into the new Model 4 world.

The cassette version of the Model 4 looks (photo 1) and acts a lot like a TRS-80 Model III in a white case. It includes 16K bytes of RAM, Microsoft BASIC in ROM (read-only memory), a 16-line by 64-column upper- and lowercase display, a parallel printer port, and a cassette I/O (input/output) port. The keyboard has been upgraded to include a control key, a caps lock key, and three function keys. Those are the only new features that are standard with the cassette-based Model 4. You must add at least one disk drive to get any other Model 4 features, even the internal speaker.

The single-disk system includes the above features plus one 180K-byte single-sided double-density disk drive with 40 tracks. The $1999, two-drive system also adds an RS-232C serial port.

A disk-based Model 4 is a dual-personality machine. When you run Model III software, it mimics a Model III exactly. But when you boot the TRSDOS 6.0 disk that

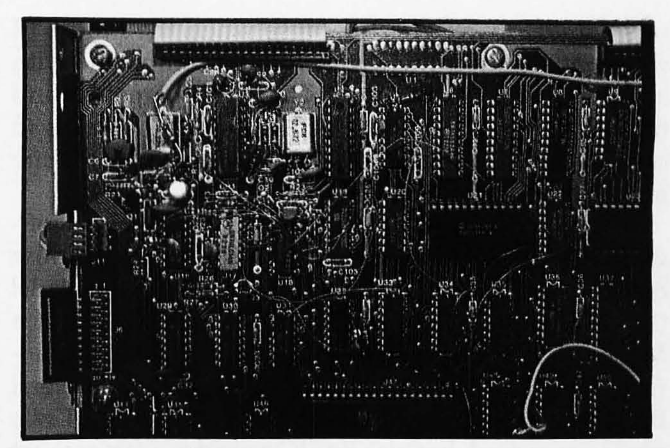


Photo 2: *A nest of blue wires bears witness to an engineering staff's last-minute work to get the bugs out of the Model 4.*

comes with any disk system or upgrade, the real Model 4 and all of its features emerge. CP/M Plus, an extra-cost option not available at the time of this writing, will also run in Model 4 mode.

Any Model 4 can be upgraded to 128K bytes of RAM. Because the Z80 can address only 64K bytes of memory at a time, the extra memory is switched in and out of the top 32K-byte bank of the Z80's address space. TRSDOS 6.0 software can use the extra memory for a printer spooler or memory disk (more on these later).

Model III Compatibility

When my Model 4 arrived, the first thing on my mind was to check out the claimed Model III compatibility. I

At a Glance

Name
Radio Shack TRS-80 Model 4

Manufacturer
Radio Shack
One Tandy Center
Fort Worth, TX 76102

Price
$199 (16K bytes of RAM; cassette storage)
$1699 (64K bytes of RAM; one disk drive)
$1999 (64K bytes of RAM; two disk drives)
$149 (additional 64K bytes of RAM, 128K bytes maximum)

Dimensions
18½ by 20½ by 12½ inches
36 lbs. (with two disk drives)

Processor
Z80A running at 2 MHz (Model III mode) or 4 MHz (Model 4 mode)

Memory
16K bytes of RAM minimum, optional 64K bytes or 128K bytes; 14K bytes of ROM (active only in Model III mode)

Data Storage
Cassette in Model III mode; a maximum of four (two in main unit, two external) single-sided double-density floppy-disk drives holding 180K bytes each; a maximum of four 5-megabyte external hard-disk drives may be added

Keyboard
70 keys including control, caps lock, three function keys, and separate numeric data-entry pad

Standard Features
16-line by 64-column display, full ASCII character set, parallel printer port, Model III compatibility on all models; Model 4 mode with 24-line by 80-column display, sound capability on disk-based systems, RS-232C serial port on two-disk systems

Software
Runs all Model III software; all models include Model III ROM BASIC; disk systems include TRSDOS 6.0 and TRSDOS 6.0 BASIC; CP/M Plus optional

Documentation
Getting Started with TRS-80 BASIC, beginner's guide, 342 pp.
Model 4 Disk System Owner's Manual, advanced users loose-leaf reference guide, 500 pp.
Introduction to Your Disk System, TRS-80 Model 4, beginner's guide, 42 pp. All the above include table of contents and index.
Model 4 Quick Reference Guide, TRSDOS 6.0 and BASIC commands, 38 pp.

Audience
Users looking for an expandable system capable of running BASIC and a wide range of Model III TRS-80 and CP/M software

was admittedly skeptical because when the Model III was announced, it was claimed to be compatible with its predecessor, the Model I. There was some truth to this claim, but there were also enough differences to cause most non-BASIC Model I software to require modification before it would run on the Model III.

After unpacking the Model 4 and admiring its off-white, textured plastic case (no tears here for the demise of battleship gray), I plugged it in and booted up a Model III TRSDOS disk. The familiar opening graphics of a Model III appeared, and everything worked OK beginning with the "TRSDOS Ready" prompt. I ran several BASIC programs and found no problems. So far I was not too surprised, because BASIC provides a fair amount of insulation from hardware differences.

Determined to find the cracks in the Model 4's armor, I started running Radio Shack machine-language software. Scripsit, Visicalc, and Profile all checked out OK. Then I ran some non-Radio Shack arcade games—still no problems. Getting desperate, I moved on to self-booting disks such as Powersoft's Super Utility Plus. It came up flying, opening graphics and all. The Model 4 is truly compatible with the Model III.

Part of the key to the Model 4's compatibility with the Model III is the inclusion of a complete set of Model III ROMs, the chips containing Model III BASIC and the Model III I/O driver routines that handle the screen, keyboard, line printer, and cassette port. These chips enable software that makes use of Model III ROM routines to work without changes. The Model III ROMs are located at the beginning of the Z80's address space, in conflict with addresses reserved by CP/M. When you run in Model 4 mode, these ROMs are switched out of the Z80's address space and replaced with RAM. The result is a full-fledged 64K-byte Z80 machine that can run normal CP/M.

Radio Shack deserves a lot of credit for adding so many new features to the Model 4 while retaining total Model III compatibility. The Model 4 user has immediate access to a large range of Model III software and will be able to take advantage of CP/M and TRSDOS 6.0 software as it becomes available.

Screen and Keyboard

The Model 4 has four different screen formats. Two are in Model III mode: 16 lines by 64 columns and a double-width character mode with 32 characters per line. TRSDOS 6.0 automatically switches the screen to a 24-line by 80-column format. Double-width characters, in Model 4 mode, result in 40 characters per line. One annoyance is the need to readjust the brightness when you switch between 16 by 64 and 24 by 80 modes. Apparently the increase in the number of video scan lines to create 24 lines of characters reduces the brightness of each line, making the overall screen image dimmer. When a large solid graphics object is displayed, such as the Tandy hourglass logo that accompanies TRSDOS 6.0 booting, a noticeable hash pattern appears over the graphics image, and bright vertical lines occur where each column meets an adjacent column. This is not a serious deficiency but could benefit from some cleanup work in future revisions of the Model 4. As photo 2 shows, several wiring modifications were made after the PC board was designed, a sure sign that a new PC board is coming soon.

When the Model 4 is in 24 by 80 mode, the video memory is not directly accessible to BASIC programs via PEEK and POKE, as it is in Model III mode. The same physical RAM supports both the 16 by 64 and the 24 by 80 modes, but in the latter mode it is relocated out of directly addressable memory. The Model III graphics character set is available in 24 by 80 mode, and the new larger screen format has higher resolution: 72 by 160 individual pixels in Model 4 mode instead of the Model III's 48 by 128.

The new keyboard (see photo 3) adds several desirable keys to the Model III's layout: a control key (to the left of the space bar, marked CTRL), an uppercase lock key (to the right of the space bar, marked CAPS), and three function keys (over the numeric keypad, marked F1, F2, and F3). With the shift key, the function keys produce six different programmable functions. Keyboards are one of those things that no two people ever seem to agree on, but I think this one has a good feel and is pleasant to use. The control key is somewhat out of the way, down by the space bar, but it is still an improvement over the Model III, which has no control key at all.

The keyboard does not have separate keys to generate some of the less frequently used ASCII (American National Standard Code for Information Interchange) characters, such as braces ({ }) or brackets ([ ]). These characters can be generated, however, by compound key sequences such as CLEAR plus "<" to generate the left bracket, CLEAR plus ">" to generate the right bracket, and so on. Key sequences are provided for all 128 ASCII characters as well as for most of the high range codes (128 to 255).

TRSDOS lets you turn an audible key click sound on or off during key depression. The sound is very muted and seems to get lost



Photo 3: *The Model 4's keyboard enhances the Model III's with a caps lock, control key, and three function keys.*

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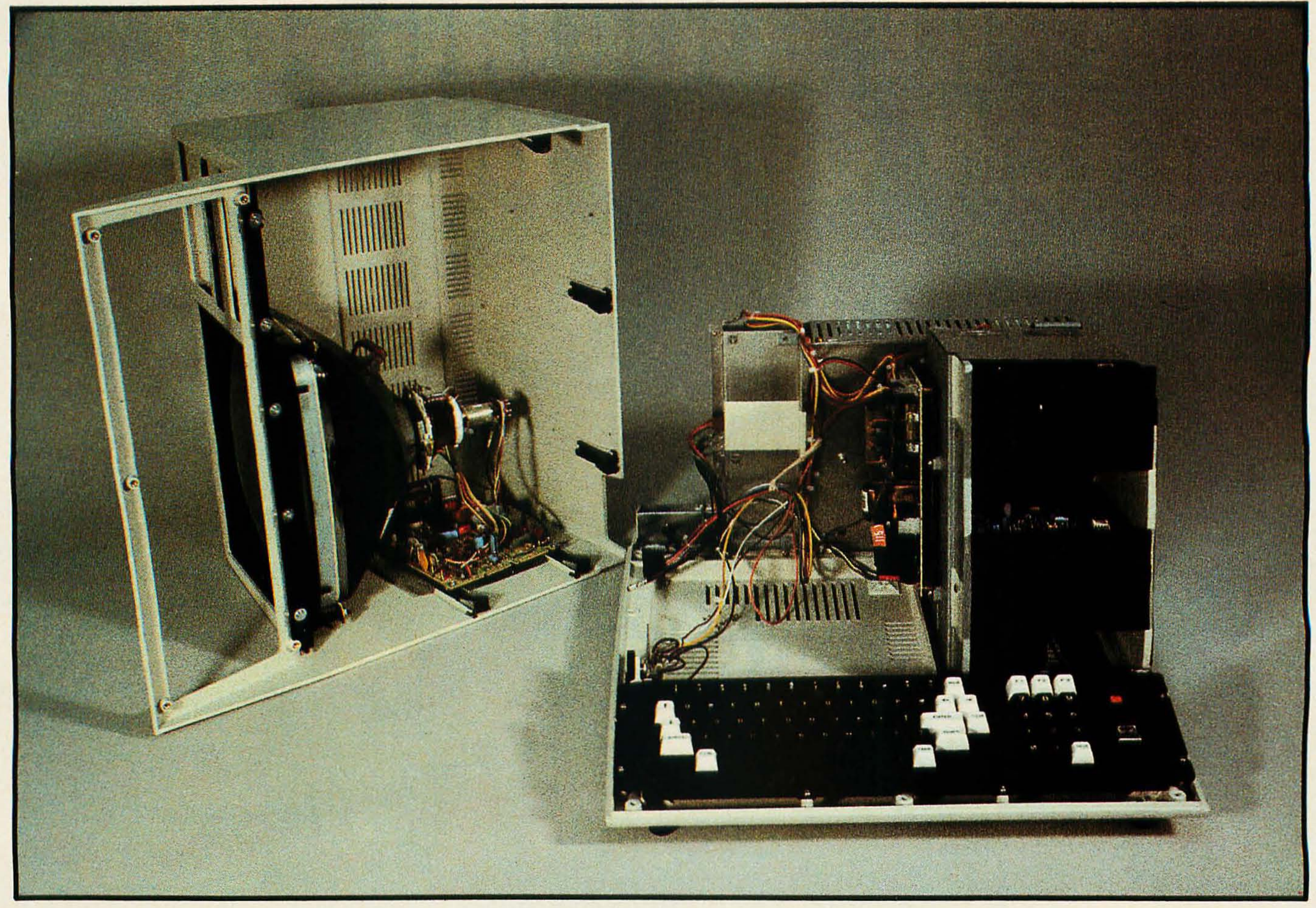


Photo 4: *The Model 4 exposed: the video-display terminal and analog video board are in the top half of the cabinet; everything else resides in the bottom half.*

in the mechanical clatter of key presses, so I left it turned off.

Inside the Model 4

The Model 4's hardware secrets are easily exposed by removing one screw on the back and 10 on the bottom of the case. The video display and analog video board are mounted in the top half of the cabinet, as you can see in photo 4. The bottom half of the cabinet holds most of the Model 4's goodies. Disk-based Model IIIs have two power supplies; the Model 4s have one, mounted vertically to the left of the disk drives. A small board carrying the amplifier and speaker for internal sound is located behind the disk drives. The RS-232C board and the disk controller are also mounted out of sight across the back of the cabinet.

A piece of grounded aluminum completely covers the motherboard, shielding nearby radios and televisions from the radio-frequency interference (RFI) generated by all computer circuitry. All potentially interfering cables are wrapped with aluminum tape to help cut RFI. This shielding pays off; I enjoy listening to shortwave stations while I compute, and my TRS-80 Model I was a horrible broadband polluter. The Model 4's RFI is barely noticeable on a radio in the same room.

Removing the shield exposes the main circuit board (photo 5). To the lower right, you can see the two banks of eight 64K-bit RAM chips that make up the 128K bytes. The three large chips at the bottom and left of center are the ROMs that hold Model III BASIC and I/O support routines.

A custom programmable array logic (PAL) chip is the second chip to the right of the ROM marked "C" at the bottom of the board. The PAL is added when you upgrade from 64K bytes to 128K bytes; because it is a custom chip, it will slow down alternate vendors of low-cost memory upgrades. The first 40-pin chip above the ROMs is the Z80 central processor; just above it is the 6845 video-controller chip. The two large chips at the center and near the top of the board, from left to right, are video RAM and the custom character-generator ROM.

A tangle of blue wire-wrap wires toward the upper left-hand corner attests to a host of last-minute engineering changes (photo 2). My test machine was serial number 5831, so Radio Shack has been doing a lot of hand-wiring.

The cassette-port connector is located at the back of the machine near the power cord feed-through. Card-edge connectors are exposed at the bottom of the Model 4 for parallel printer, external floppy-disk drive, and master I/O bus connections. RS-232C connection is made

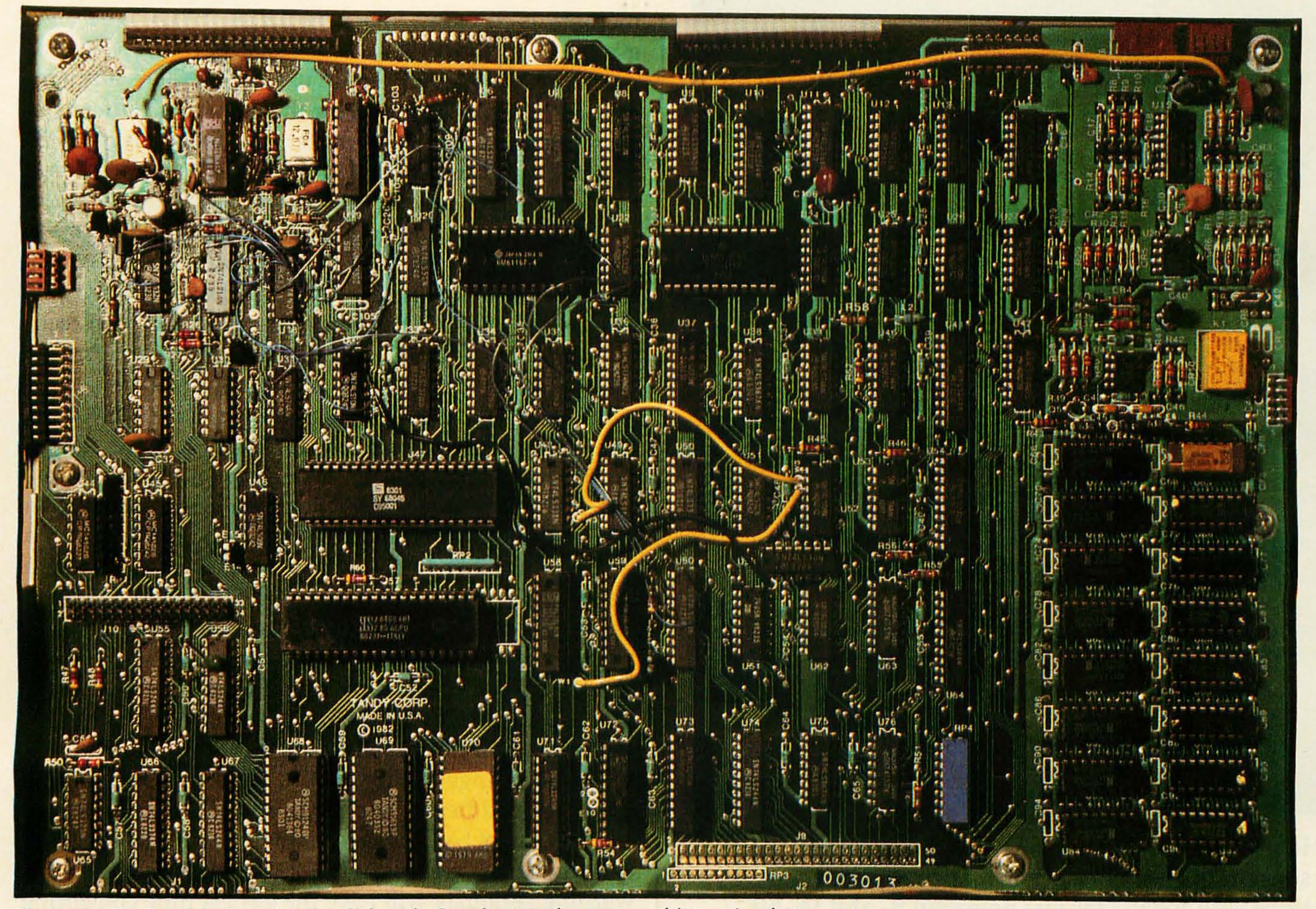


Photo 5: *The Model 4's main circuit board. See the text for a tour of its major features.*

through a female DB-25 connector on the bottom of the machine.

TRSDOS 6.0

Every disk-based Model 4 computer includes TRSDOS 6.0, which is identical to LDOS 6.00, the latest revision from Logical Systems Inc. LDOS grew out of the original TRSDOS and is largely a superset of it. It should be fairly easy for the experienced TRSDOS user to learn the essentials of TRSDOS 6.0.

TRSDOS 6.0 is totally RAM-based, meaning that it does not use any ROM support code. The Model III ROMs are switched out of the Z80's address space when TRSDOS 6.0 is running. Memory locations 0000 (hexadecimal) to 25FF are used by the resident portion of TRSDOS 6.0. Overlays are mapped from 2600 to 2FFF. User memory starts at 3000, leaving 52K bytes free in a 64K-byte system.

TRSDOS 6.0 can read and write any LDOS formatted disk and convert files from a TRSDOS 1.3 disk. All the powerful features of LDOS are included; see the March 1982 BYTE for a complete review. Suffice it to say here that LDOS is a well-documented, tested, and supported operating system that has sold thousands of copies for more than $100 each; it is a substantial piece of software to include with the Model 4.

Most of the command syntax of TRSDOS 6.0 is identical to that of LDOS 5.1.3. The following new features are incorporated as well:

- SETKI sets the delay until a key repeats and the rate at which it repeats
- KILL has been replaced by REMOVE, which accepts a list of filenames to delete (TRSDOS 6.0 BASIC still uses the keyword KILL to delete files)
- TAPE100 can read and write Model 100-format cassette tapes, allowing BASIC program and text-file exchange

As mentioned above, the Model 4 can be configured with 128K bytes of RAM. TRSDOS 6.0 includes two programs that take advantage of the extra 64K-byte bank of memory. The first, called MEMDISK, lets you address the extra memory as if it were a disk drive. MEMDISK can also work in a 64K-byte machine, using the available memory you allocate to it. Any files put in a MEMDISK will be accessed at memory speeds, much faster than floppy-disk access times. If you put the TRSDOS system overlay files there, you can make TRSDOS totally memory resident, meaning that you can take the DOS disk out of drive 0 and use that disk drive for a data-storage disk.

The other TRSDOS command that can use the extra

memory is SPOOL. Like MEMDISK, SPOOL can use available memory (and disk space) in a 64K-byte machine. The most common use of SPOOL is a printer spooler. Output destined for the printer is buffered in memory and sent to the printer whenever it is ready to accept characters to print. As long as your program's printer output does not exceed available memory, it can proceed without having to wait for the printer. For example, you can print a file from TRSDOS, then do other things while it is printing. Although the spooler worked fine from TRSDOS, the version I tested had a problem interacting with BASIC: BASIC generated an internal error whenever I tried to print using the spooler.

For assembly-language programmers, TRSDOS 6.0 has one major difference from TRSDOS 1.3: the use of "supervisor calls" (SVCs), instead of vector addresses, to call DOS routines. SVCs tie down less memory than vector addresses because one address is called with a function number in the A register instead of calling a different address for each function. The Model III's DOS vector table was located above the ROMs, putting it in the middle of user program space on the all-RAM-based Model 4. As a result, any machine-language program that used TRSDOS 1.3 vectors to perform I/O or handle interrupts will not function under TRSDOS 6.0 until it has been changed to use SVCs. LDOS 5.1.3 supported both vector addresses and SVCs, and the manual warned that the use of SVCs was recommended for compatibility with future releases of LDOS. Vendors that took this warning seriously will have the easiest time converting to TRSDOS 6.0.

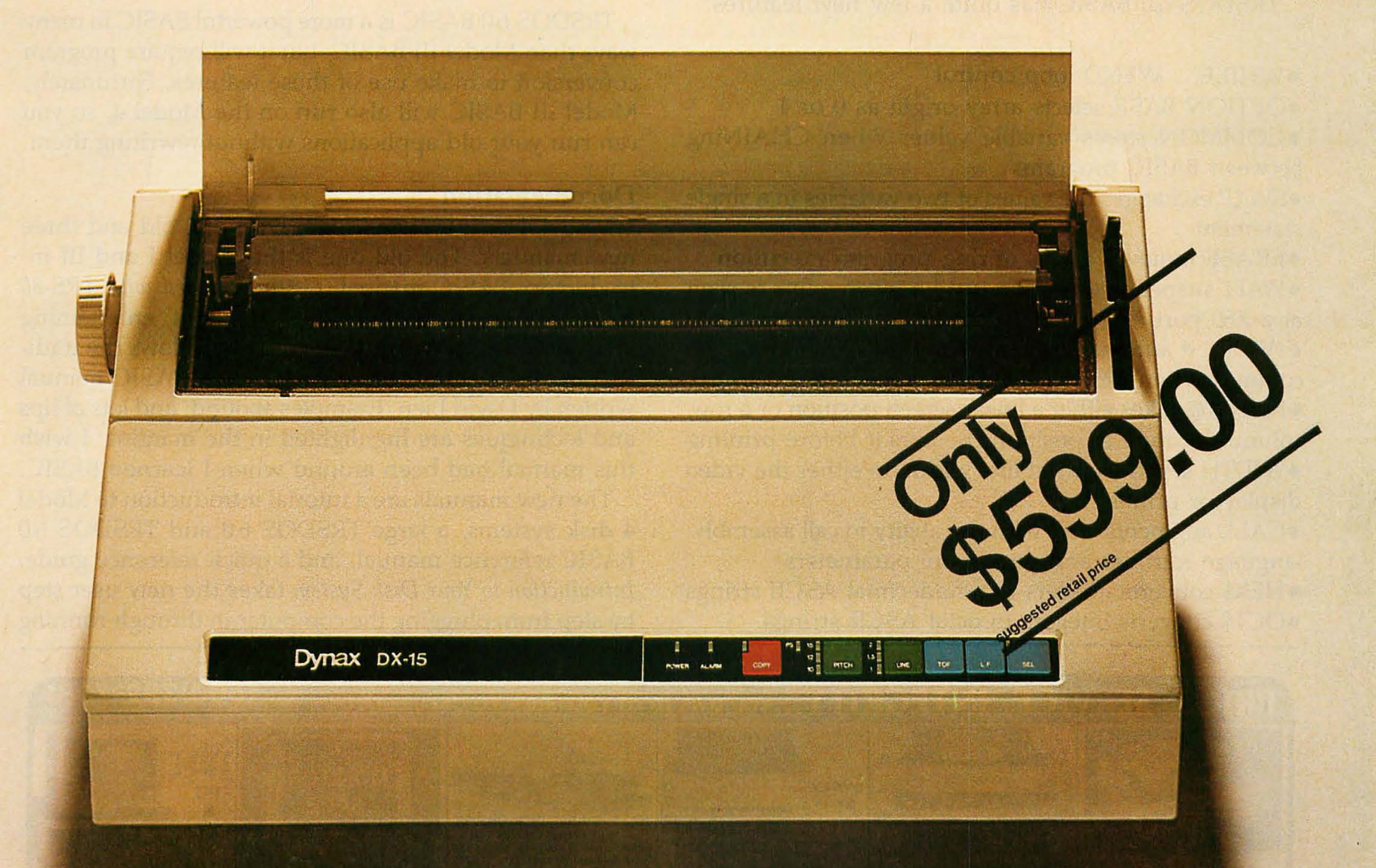
TRSDOS 6.0 BASIC

Model 4 disk systems also include a new Microsoft BASIC. Although Model 4 BASIC is largely compatible with Model III BASIC, enough differences exist that many programs will require conversion to run in Model 4 mode. The differences are as follows:

- The first 40 characters of variable names are significant; Model III BASIC supported only two significant characters
- Spaces are required between keywords and variables; Model III BASIC allowed them to be omitted in many places
- Floating-point numbers are rounded instead of truncated when they are converted to integers; e.g., PRINT TAB (X), where X is 7.5, prints in column 8 under TRSDOS 6.0 BASIC; it prints at column 7 under Model III BASIC
- ERR is the actual error number, not ERR/2+1
- POINT, SET, and RESET are gone: you can only PRINT graphics characters, and there is no way to PEEK or POKE to the screen
- If a FOR. . .NEXT loop test fails before the first time through the loop, the loop is skipped altogether; Model III BASIC always performs the loop at least once

The entire set of CMD functions (CMD "A" through CMD "Z") is gone; many of the functions have been

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replaced by new ones with different syntax, e.g., SYSTEM instead of the old CMD "S" command returns you to TRSDOS Ready. There are no replacements for the following functions, however: CMD "C" (compress a BASIC program), CMD "J" (Julian date conversion), CMD "O" (string array sort), and CMD "X" (program cross-reference).

TRSDOS 6.0 BASIC has quite a few new features:

- WHILE. . .WEND loop control
- OPTION BASE selects array origin as 0 or 1
- COMMON stores variable values when CHAINing between BASIC programs
- SWAP exchanges the values of two variables in a single statement
- ERASE removes arrays during program execution
- WAIT suspends execution until a given value is seen at a Z80 port
- WRITE # automatically supplies double quotes and commas when writing strings to a file
- PRINT @ takes either a linear screen position or a row, column location to position the cursor before printing
- WIDTH sets the output line width on either the video display or printer
- CALL augments USR with the ability to call assembly-language routines and pass more parameters
- HEX$ converts integers to hexadecimal ASCII strings
- OCT$ converts integers to octal ASCII strings
- LPOS returns the current line printer output column position
- CLEAR sets the high memory pointer and reserves stack space. CLEAR is no longer needed to reserve string space; strings use available memory dynamically
- SYSTEM("command") executes a TRSDOS command and returns to BASIC

TRSDOS 6.0 BASIC is a more powerful BASIC in many ways than Model III BASIC, but it will require program conversion to make use of those features. Fortunately, Model III BASIC will also run on the Model 4, so you can run your old applications without rewriting them.

Documentation

Model 4 disk systems come with one old and three new manuals. The old one is the Model I and III introductory BASIC manual, *Getting Started with TRS-80 BASIC*, a tutorial that is written in a light, entertaining style without being condescending. It follows the tradition of the highly commended Level I BASIC manual written by David Lien. Examples abound, and lots of tips and techniques are highlighted in the margins. I wish this manual had been around when I learned BASIC.

The new manuals are a tutorial introduction to Model 4 disk systems, a large TRSDOS 6.0 and TRSDOS 6.0 BASIC reference manual, and a quick reference guide. *Introduction to Your Disk System* takes the new user step by step from plugging the computer in through running

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BASIC application programs. A sample mailing-list program, written in BASIC, is supplied with TRSDOS 6.0. Chapter 4 takes you through the process of loading and running the program. Even though this is a small manual (42 pages), it thoughtfully includes an index.

The *Model 4 Disk System Owner's Manual*, based on the LDOS manual, is a large, loose-leaf volume containing both TRSDOS 6.0 and TRSDOS 6.0 BASIC documentation. Each command is described in detail and many examples are given. Written for the programmer, this manual is quite a step up from the introductory booklet. The LDOS technical reference section is not included here; I hope it will be in the promised technical reference manual. Those who need to interface to TRSDOS 6.0 through SVC calls should consult with LDOS 5.1.3 documentation until the technical reference manual becomes available.

The BASIC section of the manual is similar in layout and style to the TRSDOS part. A good understanding of BASIC programming is assumed, and the novice had better work through the *Getting Started* manual before tackling this one. There are a number of appendixes, including a glossary, error message discussion, a list of differences between Model III and TRSDOS 6.0 BASIC, and several on TRSDOS 6.0 programming techniques such as the use of logical devices and filters. The manual closes with a fairly complete index. This manual will require a lot of study on the part of a new user, while experienced LDOS users should have little trouble.

The *Quick Reference Guide*'s 33 pages include an alphabetical listing of TRSDOS 6.0 and TRSDOS 6.0 BASIC commands, statements, and functions. Each command's syntax is given, followed by a one-sentence description and one or two examples. I found the quick reference very helpful once I had learned a command, but not very useful for learning new commands.

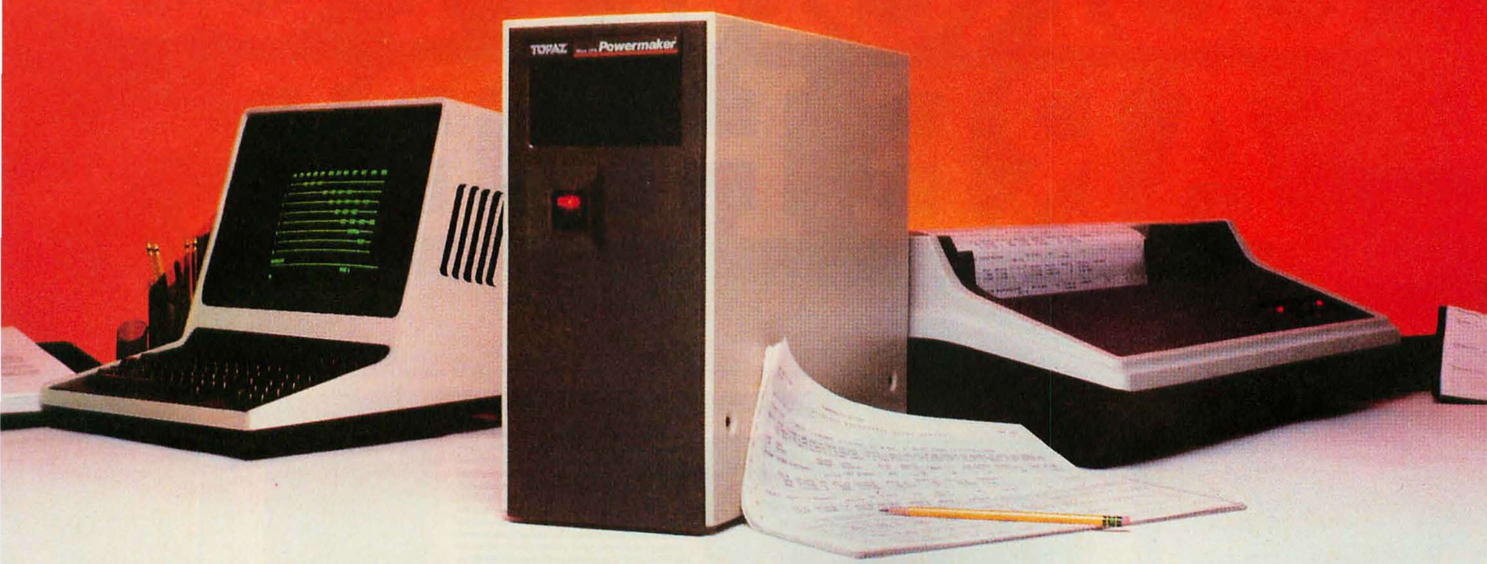
Conclusion

The TRS-80 Model 4 provides a lot of flexible computing power. It incorporates many of the most frequently requested enhancements to the Model III. Although a very large library of Model III software already exists, the lack of Model 4 mode software at the time of this review made me feel as if I was driving a sports car that was rigged to keep it from going over 55 MPH. By the time you read this, plenty of CP/M and at least some basic TRSDOS 6.0 software packages should be available.

Given all the new features in the TRS-80 Model 4 and a price that's lower than its predecessor, the popular Model III, it's safe to say that Radio Shack has a guaranteed winner.■

Rowland Archer Jr. (5420 Loyal Place, Durham, NC 27713) is manager of software development for a minicomputer company. He has been working with TRS-80s for four years.

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The Morrow Micro Decision

A look at Morrow's first effort at a single-board, stand-alone personal computer

by Tom Wadlow

A new contender has entered the field of midrange computers: the Micro Decision, created by Morrow Designs (see photo 1). Midrange computers bridge the gap between low-cost home computers, such as Sinclair, Radio Shack, and Atari machines, and the more expensive systems such as IBM's Personal Computer and the various S-100 and professional systems. The hallmarks of this breed are a large software library (included in the price of the machine) and a price that is always under $2000.

The midrange category was opened by the Osborne 1 and its close rival, the Kaypro II. The Micro Decision is similar to both these systems and should be a direct competitor with them.

Morrow Designs and its founder, George Morrow, have been in the microcomputer industry for almost as long as the industry has existed. Morrow is known primarily for his work in the area of high-quality S-100 components and systems. The Micro Decision is his first effort in the single-board, stand-alone personal computer market. It is based, in part, on the Decision I, an S-100-based system that is currently Morrow's mainstay.

System Overview

The Morrow Micro Decision is composed of a processor unit, including disk drives and input/output ports, and a terminal. The portable system is built around a single circuit board containing a Zilog Z80A microprocessor running at 4 MHz, 64K bytes of memory (no other size is available), a floppy-disk-drive controller, and two RS-232C serial ports.

The cabinet, which is similar in design to that of IBM's Personal Computer, is fairly small and will fit easily on a desk or tabletop. The top of the cabinet is a convenient place for the video display. The keyboard is not attached to the display, allowing the screen to be placed at eye level without making the computer uncomfortable to type at. The computer's Reset button is inconspicuously located at the lower right front corner of the processor unit, under the lip of the cabinet frame, making it impossible to reset the system by bumping the chassis with the keyboard. The power switch is on the back of the cabinet.

The terminal provided with the Micro Decision is a Lear Siegler ADM 20), a two-piece unit with the keyboard connected to the back of the display by a coiled 4-foot cable. Brightness and power controls are located on the front of the display. The keyboard has a numeric keypad and cursor control keys in addition to the alphanumeric keypad.

The basic Micro Decision comes equipped with a single 5¼-inch disk drive that holds approximately 200K bytes of information and software that allows you to read and write disks in Osborne, Xerox, and IBM formats.

Micro Decision Hardware

One of the two serial ports is dedicated for communications with the terminal, and the other can be used as a printer port or for connection to a modem. There is also a connector to allow additional disk drives. Lack of a third port is somewhat annoying, as most people prefer not to disconnect cables to switch between their modem and printer. Fortunately, the terminal is equipped with

an auxiliary serial port, and cable swapping can be avoided by connecting the modem to the second serial port and the printer to the terminal's auxiliary port. Morrow should consider, however, addition of a parallel printer port to leave the second serial line free for the modem. This would allow greater printing speed and a wider choice of printers.

Disk Storage

Unlike the Osborne and Kaypro, which each come equipped with two 5¼-inch disk drives, the Micro Decision basic system has only one. The basic drive is single-sided single-density and stores about 200K bytes. Also available are double-sided double-density drives. Programs distributed with the system allow the user to set drive characteristics so that the Micro Decision can be used to read and write formats other than its own. Currently, programs are available for IBM Personal Computer (CP/M-86, *not* PC-DOS), Osborne, and Xerox disks.

I reviewed a Micro Decision 3. The differences between systems 1, 2, and 3 are in the type of disk drives that are installed. An MD-1 is a system with a single two-thirds-height 5¼-inch drive, an MD-2 has a pair of two-thirds-height drives, and an MD-3 has between two and four half-height drives. The MD-1 and MD-2 drives are single-sided, with 200K bytes of storage per drive. The half-height drives for the MD-3 are double-sided with 384K bytes per drive. The drives for all systems are manufactured by Tandon.

Tandon half-height drives are very quiet. I would not hesitate to recommend them for use in a small office, where even the hum of a fan can be annoying. On the same note, the Micro Decision has no cooling fans, so other than the faint, intermittent noise of the disks, the unit is absolutely quiet. All Micro Decision drives spin for a few moments after they have been used and then shut down to preserve the media and the equipment (Tandon drives are also fast). Other pleasing features of the system include the Morrow virtual-drive capability and the rewritten software for the disk controller.

The Micro Decision can have up to four physical drives and any number of virtual drives. For example, if you reference a third drive in a two-drive system (perhaps by performing a "STAT C:"), the BDOS (basic disk operating system) will redefine drive A: as drive C: and ask you to change floppy disks. A reference to drive A: will undo the change, again causing a request for you to swap disks.



Photo 1: *The Morrow Micro Decision. The system consists of a single-board computer based on Zilog's Z80 processor, some number of 5¼-inch floppy-disk drives, and a Lear Siegler ADM 20 terminal. At press time, Morrow planned to offer a Freedom terminal with the system instead of the Lear Siegler terminal.*

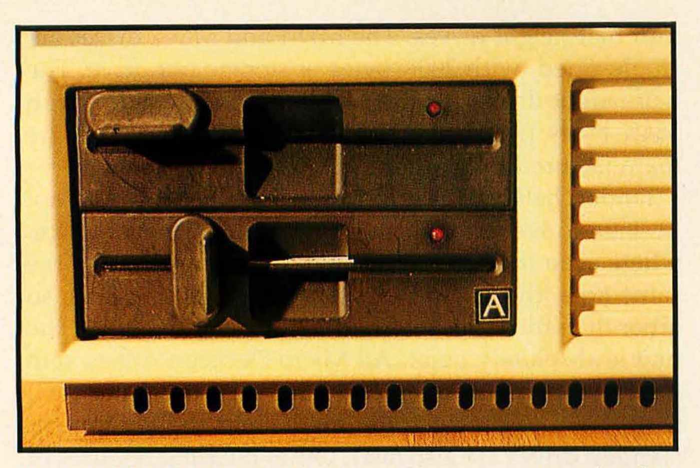


Photo 2: *This photo shows the rather odd arrangement used to close the disk drives.*

Rewritten software for the disk controller offers the user a choice of responses when faced with CP/M's BDOS error messages. Instead of "BDOS ERROR on B:R/O," the user is now given the option of retrying, aborting the operation, or ignoring the error.

One feature of the system that I did not care for, however, was the knob used to secure the media in the drive (see photo 2). Instead of the usual "garage-door" type latch, these knobs must be turned 90 degrees to close the drive. This is an unnatural motion for most people. But it is a minor inconvenience when considering there are four disk drives in a small enclosure.

The Terminal

My misgivings about this system concern the terminal. I found the keyboard layout poor. For example, the Control key is next to the Space bar, putting it underneath the palm of the left hand; the cursor control keys are in the top row, above the number keys, when there is a numeric keypad that could have doubled as arrow keys (as on many popular terminals); there is a huge Caplock key, but a tiny Delete key; and the terminal has an extremely loud and annoying bell tone, with no volume control.

The display, however, is crisp and clear. The terminal has two levels of brightness (an advantage in the menu-driven CP/M provided by Morrow).

Very little information about the terminal comes with the computer. In addition, the terminal is delivered unconfigured. A new Micro Decision user must set the terminal characteristics using a single sheet of instructions and two cursor keys while looking at a baffling row of 1s and 0s that appear at the bottom of the screen. Fortunately, the terminal has a nonvolatile memory, so this setup need only be performed once.

Software

Like the Osborne and the Kaypro, the Micro Decision comes equipped with a basic set of programs, making the computer useful immediately. It also is equipped with a CP/M-compatible screen-oriented text editor, a spreadsheet program, and a database manager.

Morrow PILOT and CP/M: When the Micro Decision's operating system is first loaded, the computer displays a menu of available CP/M commands (see photo 3). This menu is written in PILOT (Programmed Inquiry, Learning or Teaching language), originally designed for writing computer-aided instruction lessons. The menu system provides a clean, simple way to use most of the capabilities of CP/M. Each possibility is described clearly and concisely, with the CP/M command that will be invoked listed with the explanation. Two or three keystrokes will implement almost any command. As each command is executed, the user can watch PILOT invoke the commands from the conventional CP/M prompt. For a novice user, this automated walk-through makes up for the slowness of the menu system because he or she can see the command happening each time. After watching menu commands, the user should gain the confidence and familiarity with CP/M to try the system in the usual interactive manner.

From the menus it is also possible to call each of the packages provided, such as Wordstar and Logicalc. An ambitious user could learn PILOT well enough to add entries to the menu, or perhaps entire new pages containing customized menus.

Logicalc is an interactive spreadsheet program, following the tradition of Visicalc. A spreadsheet calculator consists of an array of cells; each may contain a number, a label, or an equation based on the value of other cells.

At a Glance

Name
Morrow Micro Decision

Use
Personal and general-purpose computing

Manufacturer
Morrow
600 McCormick St.
San Leandro, CA 94577
(800) 521-3493

Size
16.7 by 5.3 by 11.3 inches

Standard Features
Hardware: 4-MHz Z80A processor, 64K bytes of RAM
Software: CP/M 2.2 disk operating system, Wordstar, Correct-It, Logicalc, Microsoft BASIC, North Star-compatible BaZic, Personal Pearl Database

Options
May be ordered with a Lear Siegler ADM 20 video terminal and one or two single-sided disk drives, or two double-sided half-height drives

Price
With one drive: $1195; with two drives: $1545; with two half-height drives: $1695; $595 for the video terminal

Mass Storage
Up to four 5¼-inch floppy-disk drives

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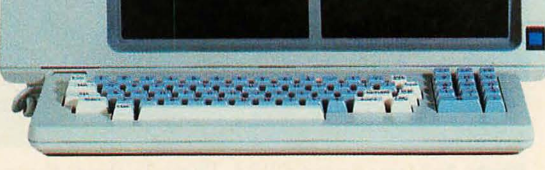
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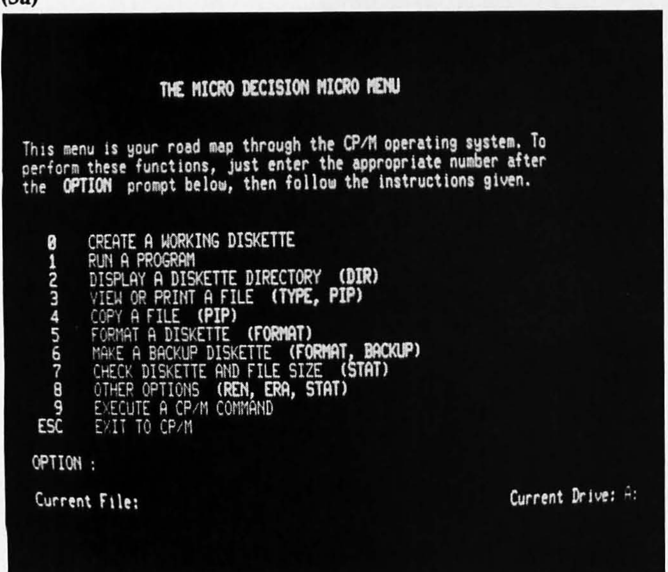


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(201) 944-6700 • ***CALL:* (800) 221-1565** • Telex: 144594

#800

(3a)



(3b)

```
DISPLAY A DISKETTE DIRECTORY (DIR)

You may obtain an on-screen list of files on a diskette by
entering your choice after the OPTION prompt.

   1    Display of files on current drive
   2    Display of files on another drive or diskette
  ESC   Exit to CP/MENU

OPTION :
```

(3c)

```
COPY A FILE

Choices in this menu allow you to copy a single file, or a group
of files, onto another diskette.  The diskette upon which the
files will be copied must already be formatted and have enough
room to accept the new files.  Enter your choice from the list
below after the OPTION prompt.

   1    Copy a single file to another diskette
   2    Copy all files on one diskette to another diskette
  ESC   Exit to CP/MENU

OPTION :_
```

Photo 3: *Menu-driven CP/M. Photo 3a shows the main menu and the CP/M commands that may be accessed through it. Photos 3b and 3c show the submenus for displaying the directory of a disk and copying a file.*

By changing the value of key cells, it is possible to play the game of "what-if?" Spreadsheets are popular with people who work with a large volume of interrelated numeric calculations.

Logicalc can handle a universe of 255 rows by 127 columns of cells. Of those 32,385 cells, only 10 rows by up to 15 columns are visible at any one time, using the standard display mode. An extended-screen mode is provided that permits a display of 15 rows (see photo 4).

Correct-It is an interactive spelling corrector. Given the name of a text file, it will pass through the file and display words it does not recognize. You can leave the word as is or correct it in the text. Correct-It is well written, but slow.

Logicalc is not as easy to use as Visicalc, creating some problems for novice users, but it does the job. Its major failing in the Micro Decision environment is that it is not integrated well with this computer. Logicalc does not require the use of terminal cursor keys, but rather a group of control characters on the left side of the keyboard. With the inconvenient placement of the Control key, my left hand was cramped during extended Logicalc use. Also, I found the Logicalc installation process confusing.

Another problem with Logicalc is its lack of compatibility with other packages. Although it can save and load spreadsheets, the format of those files is not in the DIF (Data Interchange Format) standard, making it impossible to use Logicalc in conjunction with other popular software on the market. It is, however, compatible with packages written by Software Products International, the authors of Logicalc.

Wordstar and Correct-It: Wordstar is one of the most popular personal computer text editors on the market today. It is a screen-oriented editor that is used as both a word-processing system and in the creation of software.

Correct-It is an interactive spelling corrector written by Aspen Software. Given the name of a text file, Correct-It will pass through the file and display words it does not recognize. The user has the option of leaving the word as is or correcting it in the text. Correct-It can add to its dictionary, so that it can "learn" new words as they occur in the text. It has a basic dictionary of 36,000 words and knows about the dot (text formatting) commands used by Wordstar.

Correct-It is well written, but slow. It took approximately a minute to load and sort a text file that consisted of a single sentence of 14 words, three of which were misspelled. For full-sized documents, it would be usable, but frustrating.

MBASIC and BaZic: The Micro Decision is available with two versions of BASIC. Microsoft BASIC is a stan-

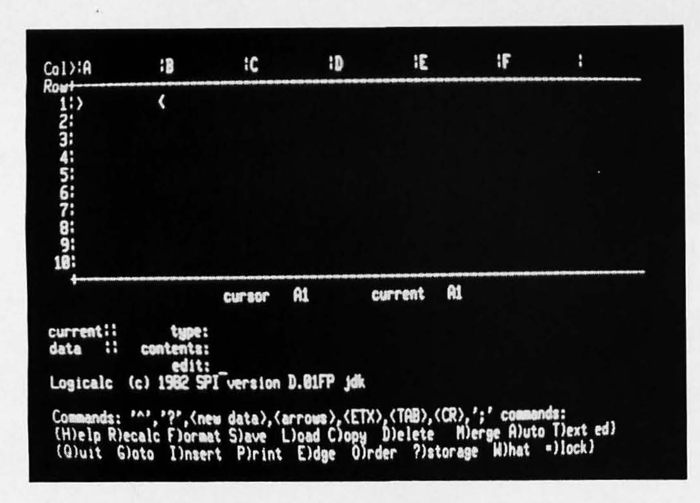


Photo 4: *The Logicalc spreadsheet program.*

dard in the personal computer industry, running on both 8080 and Z80 microcomputer systems. BaZic is a North Star-compatible BASIC interpreter (written by Micro Mike's Inc. of Amarillo, Texas) that uses the full Z80 instruction set. It is faster than MBASIC but more idiosyncratic. Many, but not all, MBASIC programs will run under BaZic.

Personal Pearl will be the database manager distributed as standard software with the Micro Decision. At the time of this review, Personal Pearl was unavailable for examination.

The Bottom Line

As previously stated, the price of midrange computers is approximately $2000, and the price of various versions of the Micro Decision is roughly the same. However, the Micro Decision price can be reduced. It can be purchased without a terminal ($595), bringing the price of the basic unit (MD-1) to $1195. The MD-2 costs $1545, and the MD-3 costs $1695. Full systems cost $1790, $2140, and $2290, respectively.

Comments and Conclusions

The Micro Decision would make a good second computer for people who are familiar with CP/M systems or for those who have had experience with computers. From a hardware-design standpoint, the system is well constructed and reliable. Morrow's software is not suitable for novice users; the documentation for Logicalc and Correct-It consists of references containing little in the way of tutorials (tutorials and examples are vital for inexperienced users).

The major failing of the system is its terminal; however, it is possible to purchase a Micro Decision without one. The software can be configured to work with most popular terminals on the market today.■

Tom Wadlow is an engineer and freelance writer living in the San Francisco Bay area. He can be reached at Apt. 226, 5157 Norma Way, Livermore, CA 94550.

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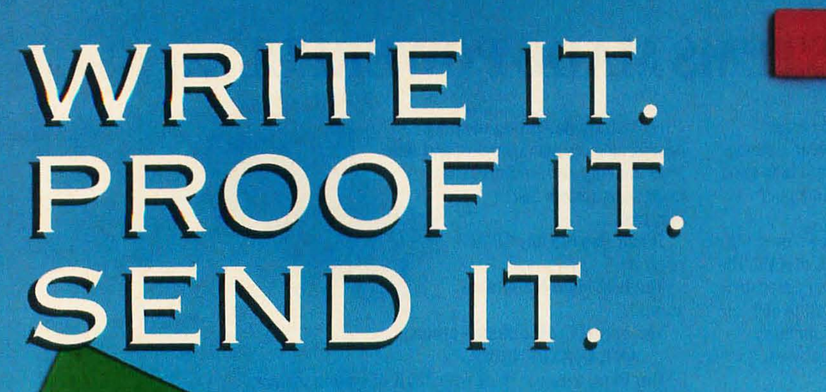
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The Microneye

This low-cost image-sensing camera interfaces easily with a variety of popular microcomputers

by Dr. Chris Wieland

If you stop and think for a minute about science-fiction movies in which a computer goes wild and turns on its owner, the computer always possesses one attribute—vision. Invariably, as its hapless victim tries one thing after another to escape, the mad computer watches, blocking each attempt at just the last minute, the better to torment its victim. One can only assume that computers have a twisted sense of humor; surely, many computer users can attest to that fact.

Fortunately, such computers have thus far been kept in check because the cost of adding vision has been out of reach for nearly all computer users. So far, few stories have appeared in the newspapers about home computers turning on their owners. This situation may change dramatically, however, thanks to the introduction of a product called the Microneye.

The Microneye is a low-cost (as little as $295) imaging system designed to interface easily with a variety of popular microcomputers. Made by Micron Technology of Boise, Idaho, this solid-state camera is capable of recording high-resolution images at rates of up to 15 frames per second (or a frame every 67 milliseconds). In other words, this imaging device can function as a movie camera, catching the activity of any moving object. Con-



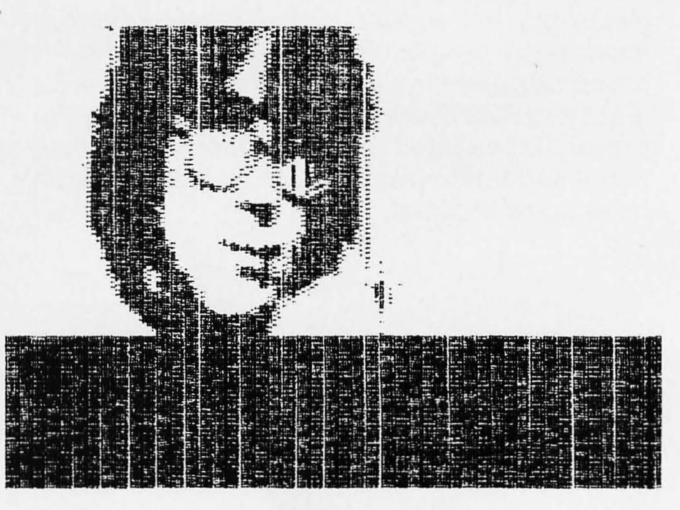


Figure 1: *Two examples of images produced by the Microneye solid-state camera. On the left is a view of one of those annoying subscriber cards that fall out of magazines. On the right is a picture of a photograph of the author. The card was photographed at a distance of about 3 feet, the author's photo from about 5 feet. Both images were displayed on an Apple high-resolution screen and printed on an Axiom printer using a screen-dump routine. The broad black band at the bottom of each image is a result of the fact that the 256- by 128-pixel area of the Microneye does not completely fill the 256- by 192-pixel area of the Apple's high-resolution screen.*

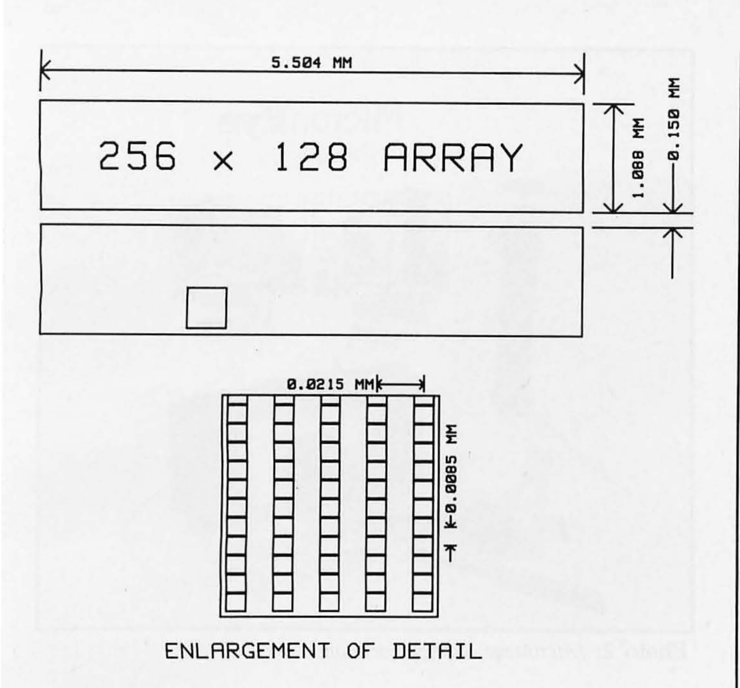


Figure 2: *Dimensions of the photosensitive array of the IS32 Optic RAM chip. Enlargement shows center-to-center spacing distances of individual light-sensing elements (pixels). Each pixel is 8 by 9 micrometers. Array and detail dimensions are drawn to scale.*

At a Glance

Name
Microneye Bullet, Microneye camera, and RS-232 camera package

Manufacturer
Micron Technology Inc.
2805 East Columbia Rd.
Boise, ID 83706
(208) 383-4000

Price
Microneye Bullet camera, $295; Microneye camera, $485; RS-232 Microneye camera package, $540

Hardware Required
Apple II Plus, IBM PC, or Commodore 64 with one disk drive; Radio Shack Color Computer or Commodore 64 with cassette interface; or any computer with RS-232C interface for RS-232 unit

Documentation
19-page operator's manual; program listings on copyable disk

Audience
Anyone who needs low-cost, high-resolution imaging

sequently, the Microneye can be used for motion detection or image analysis; the camera can replace similar, but more expensive, solid-state systems such as those based on CCDs (charge-coupled devices) or photodiode arrays.

Inside the Camera

The basis of the Microneye camera, and a major reason for its low cost, is an integrated circuit called the IS32 Optic RAM, manufactured by Micron Technology. The RAM in the name of this image-sensing chip is well chosen because the chip is precisely that, a dynamic 64K-by 1-bit RAM (random-access read/write memory) circuit modified for image-sensing capabilities. This chip keeps the cost of the Microneye quite reasonable because the process of manufacturing dynamic RAM chips is already well established; thus, Micron avoided the cost of developing a totally new silicon technology.

Forming an Image

If you are familiar with the operation of dynamic memory, you know that dynamic RAMs must be refreshed (recharged) every so often or they lose their data. Each storage location, or bit, in the memory acts like a tiny capacitor or battery that slowly loses its charge if it is not periodically refreshed to its original voltage level.

When light falls on the surface of a dynamic RAM silicon chip, it accelerates the rate at which charge is lost from the memory locations in the chip. This photosensitive property is the basis of the image-sensing capability of the IS32 Optic RAM. The Microneye produces a picture for the host computer when an image is optically focused on the surface of the Optic RAM. Light from an image reaches the surface through a rectangular quartz window in the top of the IC. The window covers the small square of silicon comprising the chip and makes it look physically much like an EPROM (erasable programmable read-only memory) chip. To create the image, the data in every memory location is initially set to a value of logic 1. Then, after a specific delay, the data from the memory is read back. Under normal circumstances the data does not change; it is still all 1s. However, because light focuses on certain areas of the chip, indeed on specific memory storage "cells," the discharge rate of these memory locations accelerates. As a result, the contents of these particular memory locations change from 1s into 0s.

Now, if you take each memory location and display it on your computer's graphics display in the same configuration found on the surface of the Optic RAM (using a white dot to represent a 1 and a black dot to represent a 0), you'll have a picture of the image focused on the chip (figure 1).

The resolution of the IS32 Optic RAM chip is 128 by 256 pixels (picture elements). However, the Optic RAM actually contains two 128 by 256 photosensitive arrays separated by a narrow nonphotosensitive strip (see figure 2), making a total array size of 256 by 256 elements. Through software manipulation, you can partition the array into smaller units to provide, for example, zoom effects or to meet user requirements dictated by limited memory space. Thus, depending on your needs, you can form the picture into a square of 100 by 100 pixels or a long rectangle of 256 by 8 pixels.

You can choose from three models—the Microneye Bullet, the Microneye camera, and the RS-232 Microneye

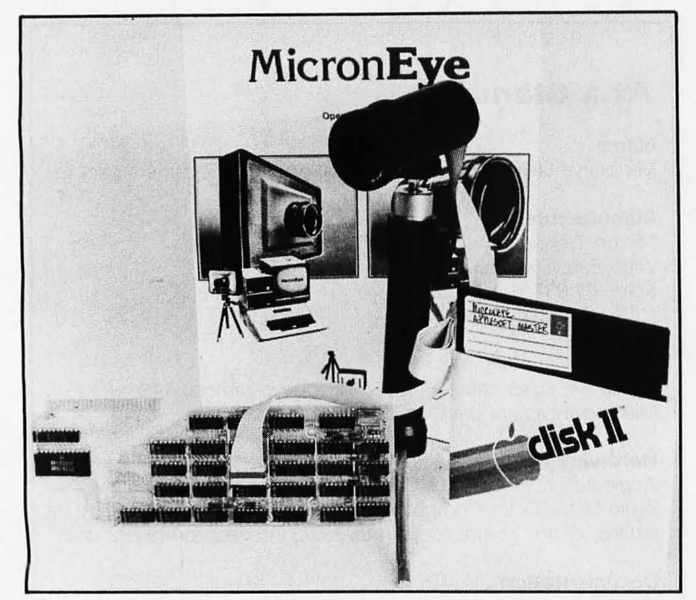


Photo 1: *Microneye, Bullet version.*

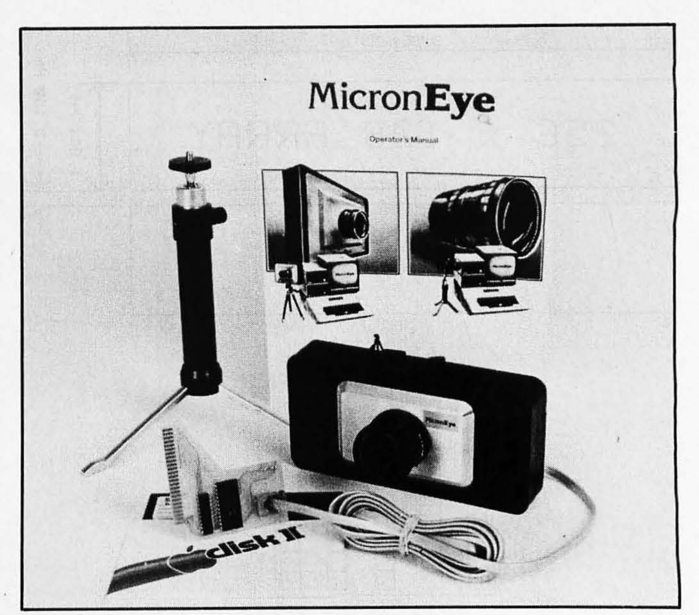


Photo 2: *Microneye, camera version.*

camera—to meet your computer, budget, and image-sensing requirements. The Microneye Bullet (photo 1) is designed for use with the Apple II Plus, the IBM Personal Computer, the Radio Shack Color Computer, and the Commodore 64. The name Bullet refers to the shape of the cylindrical case in which the image-sensing element is housed. This unit is quite small—less than 3½ inches long and 1½ inches in diameter—and is composed of only a C-mount lens and the IS32 Optic RAM chip in a cylindrical housing. A double-sided PC board that plugs into a specific user slot on each computer contains the electronics that interface the chip to the computer. Because the controls of the IS32 Optic RAM are located within the computer and because many signals must travel between the interface board and the Bullet unit, a user is limited to 4 feet of cable connecting the computer to the Bullet.

I am currently using this version with my Apple II Plus computer and find the short cable to be only slightly restrictive. A nice feature of this unit is its small size; it can be mounted where other image-recording devices would never fit.

A second version, the Microneye camera, has all the interfacing electronics, along with the Optic RAM and the lens, located in the camera case (photo 2). With this version, a six-conductor modular telephone cable connects the camera to a small 3- by 3-inch card located in the computer, allowing remote sensing at distances of up to 25 feet (although only a 6-foot cable is supplied with the unit). This second version is available for the same four computers listed for the Bullet.

The third version, the RS-232 Microneye camera, is fully self-contained and enables data and camera commands to be sent over a standard RS-232C interface, making it usable with nearly any computer. Externally, the RS-232 version looks identical to the Microneye camera.

Included with each camera is an easy-to-use software-driver package. This package comes on a 5¼-inch disk for the Apple II Plus, IBM PC, and Commodore 64 or on cassette tape for the Radio Shack Color Computer and Commodore 64. Pascal and 6502 assembly-language listings are available for the RS-232 version. A small tripod is also included for camera mounting. All versions derive power from the host computer and use only 50 milliamperes of current from the +5-volt supply, owing to the extensive use of CMOS (complementary metal-oxide semiconductor) circuitry.

The User Interface

The software driver is quite easy to use; it is clear that Micron Technology worked hard to develop a software package that lets you quickly start up the camera with a minimum of difficulty and allows you to retain complete flexibility in changing the camera's operating mode. The main program begins by presenting a menu of operating conditions you select through single keystrokes. You can control the light sensitivity of the camera by selecting options from the menu; exposure times may be set at ranges from 0.001 seconds for bright images to 60 seconds for dimly lit scenes or time-exposure effects. In addition, the exposure rate can be set to a mode in which the time is automatically changed to match a user-selected light level. Pictures may be saved or loaded from the storage medium or dumped to a printer with graphics capabilities. When you use a graphics printer for display, you can generate images using gray levels (figure 3). This image generation is accomplished by averaging multiple samples of the same image (taken at varying exposures) to estimate the relative intensity of each pixel.

The software can be listed and copied and is fully documented with comments that even encourage a user to make modifications.

Possible Applications

If the preceding description has not yet made you rush to order the Microneye, perhaps a few ideas about ap-

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Single Sweep	—	—	Yes
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Scopes are UL Listed, CSA and VDE approved.



plications will change your mind. My own application for the Microneye involves automation of scientific animal-behavior experiments. Many studies of animal behavior require that the position, orientation, or mechanical motion of animals be recorded. Often, such material must be recorded for long periods of time at evenly spaced intervals; at other times, the activity to be recorded may last only 5 seconds and need to be analyzed 10 times per second. Such studies can be carried out with videotape or film systems; however, the extraction of data from these media is tedious, to say the least, and the cost of either system is prohibitive.

Because of the limitations of video and film, the introduction of the Microneye is welcome. Now, for a very low cost, the experiments mentioned above can be carried out automatically by a camera and computer; data collection as well as analysis can be automated (figure 4).

Some other applications for this solid-state camera include robotics, motion detection, security systems, image analysis and pattern recognition, graphic arts work, remote sensing stations, position and size monitoring for production, and inexpensive reading machines for the blind.

The Microneye camera is an extremely versatile image-sensing device that can be used in many personal, scientific, or industrial applications. The unit's cost, relatively low compared to standard video systems or more exotic schemes of image recording, makes it particularly attractive.■

Editor's Note: *For information on how you can build a digital camera similar to the Microneye, see page 67.*



Figure 3: *An example of an image incorporating gray levels, generated with a graphics printer.*

Dr. Chris Wieland (Campus Box B-334, University of Colorado, Boulder, CO 80309) holds a PhD in biology. A research associate at the University of Colorado, he is studying the neurophysiology of animal behavior.

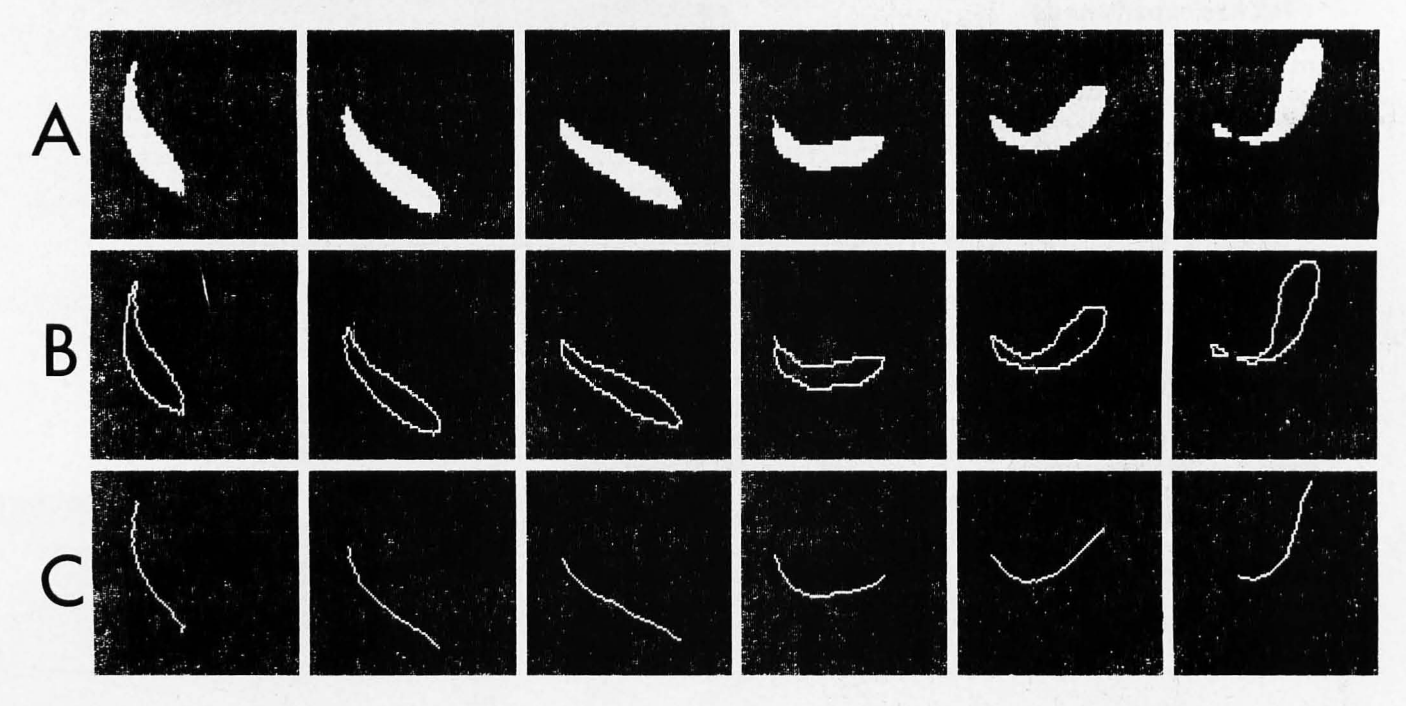


Figure 4: *An example of image analysis based on a digital image generated by the Microneye. Shown are sequential frames, "filmed" from beneath a glass aquarium, of a goldfish executing a turn. Using binary image information supplied by the Microneye camera and image-analysis programs (designed by the author and not supplied with the camera), it is possible to determine mechanical properties (such as angular velocity and displacement speed) of the fish's turn. Time between each frame is 370 milliseconds. A shows the fish silhouette (the original camera image); B, the computer-generated outline; and C, the computer-generated midline.*

VoiceDrive...



USING A COMPUTER HAS NEVER BEEN THIS EASY.

The M68000 Educational Computer Board

A look at Motorola's $495, 68000-based single-board computer

by Robert W. Floyd

If you're interested in getting acquainted with Motorola's 68000 16-bit microprocessor but can't part with $5000 or more, Motorola offers a usable system for only $495. For that price, don't expect a disk drive and a Unix operating system, but do expect a 68000-based single-board computer with 32K bytes of RAM (random-access read/write memory) and what may be the best monitor program in ROM (read-only memory) ever developed.

At $495 per unit, Motorola is not going to get rich by selling its Educational Computer Board (ECB). Obviously the strategy is to educate the coming generation of engineers and programmers about the 68000, with the expectation that they will design products that use the 68000. In addition to its intended audience of educators and students, this board is of interest to both hobbyists and people involved in developing 68000-based products. It is *not* a development system, but its interpretative assembler and disassembler make it handy to quickly test short routines.

The 68000

The 68000 is becoming an increasingly important microprocessor in today's market, as evidenced by the frequent announcements of products using the 68000. The chip is expandable by design, and Motorola has announced that a full 32-bit version will be available in 1984. Before jumping on the bandwagon, however, you should know that the 68000 is not just a bigger version of the old 8-bit microcomputer; it is considerably more complex than many of the 16-bit minicomputers popular since the 1970s.

Before reviewing the system, I'll briefly highlight some of the major differences between the 68000 and the old 8-bit devices we're familiar with. The machine language supports byte, word (16-bit), and long-word (32-bit) operations. It has eight data registers and eight address registers, each 32 bits wide. Except for one register, A7, which is always the current stack pointer, all address and data registers are treated identically.

The processor operates in two states: user and supervisor. Certain instructions are legal only in the supervisor states. Once in the user state, the processor will stay there until an *exception* occurs. Exceptions may be caused by resets, interrupts, bus errors, a variety of run-time errors, and executions of TRAP. Besides some of the interrupt conditions, all exceptions are auto-vectored; when the exception occurs, the processor gets the address of the exception-handling program from a specific location in memory. These exception vectors take up the first 1K bytes of memory and should all be initialized immediately after a reset occurs if you don't want your processor going off in strange directions.

The large number of 16-bit op codes makes a greater assortment of instructions possible. In the 68000, these possibilities appear as both new operations and a vari-

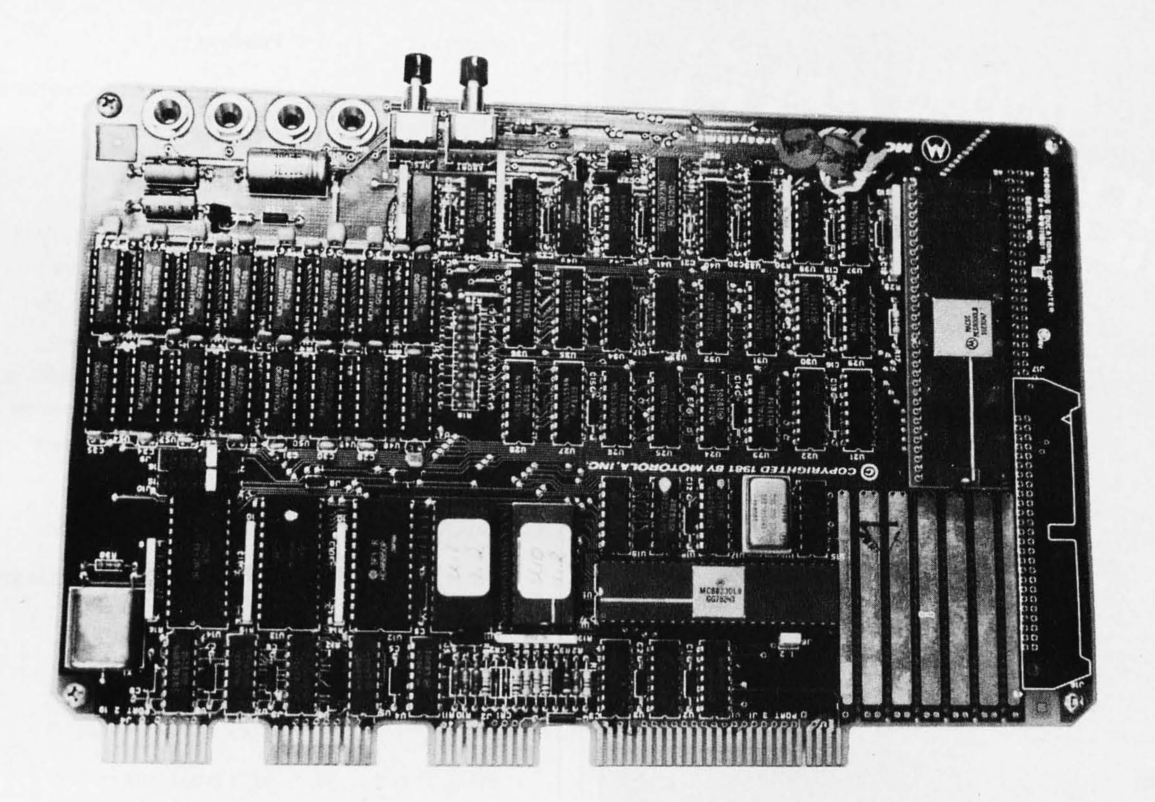


Photo 1: *The very large integrated circuit (IC) in the upper right is the 68000. The other large IC near the wire-wrap area is the 48-pin MC68230 parallel interface/timer. The two serial interface ICs are at lower left. The edge connectors on the bottom are, from left to right, serial port 2 (host), serial port 1 (terminal), port 4 (cassette recorder), and port 3 (Centronics-type parallel printer).*

ety of addressing modes for the standard operations. Most of these operations fall into the general scheme of supporting higher-level languages. These include instructions such as a branch subroutine (BSR), which allows relative branches to any address within 32K words above the program counter's address; the LINK and UNLINK instructions, which ease the construction of reentrant subroutines; and the move-multiple-registers instruction (MOVEM) for quickly saving registers. In addition, 12 addressing modes contain many instructions. These different modes are available for data transfer and logical and arithmetical operations. They can also be used in some of the transfer-of-control operations. In other words, a jump to subroutine (JSR) doesn't have to go to an absolute address—it might go to the address calculated by adding a data register to an address register plus an immediate value included in the instruction (by the way, that's one I haven't used yet). The result of this addressing arrangement is that it takes skill to write a program shorter than 64K bytes that is *not* relocatable, and it is very easy to write reentrant subroutines.

If Motorola simply added eight more address and eight more data lines to an 8-bit processor, only 56 pins would be needed. You well might ask what other functions have been added to require 64 pins. First, the 68000 is asynchronous in operation; it will not terminate any bus cycle until it recognizes that data transfer is complete, which is normally done by having the memory or peripheral device assert a data transfer acknowledge (DTACK). Because not all devices run asynchronously, the 68000 has a provision for synchronous devices, particularly those designed for the old 6800 microprocessor. In this case, a line called valid peripheral address (VPA) is used instead of DTACK.

When the 68000 detects this signal, it replies with a valid memory address (VMA) signal and synchronizes the bus operation to the Motorola 6800 E cycle. To provide more flexibility in the interrupt structure, three interrupt control lines produce seven levels of interrupts. Three bus arbitration lines allow DMA (direct memory access), refresh, and so on. One last note—RESET is bidirectional, so the 68000 can execute an instruction that resets all peripheral devices but does not affect operation of the processor.

Hardware

Let's take a look at what you get for $495. The ECB is a single-board computer measuring 7½ by 10½ inches. The quality of construction is excellent. The board's edge contacts as well as its traces are gold plated. The ECB provides a 68000 operating at 4 MHz, a 16K-byte ROM monitor, 32K bytes of dynamic RAM, two RS-232C serial interface ports, and the MC68230 parallel interface/timer (PIT) that provides a cassette tape recorder interface, a Centronics-type printer interface, a 24-bit timer, plus

Mnemonic	Function
HE	help; displays Tutor commands
MD	memory display
MM, M	modify memory
MS	store into memory
.A0–.A7	display/set address registers
.D0–.D7	display/set data registers
.PC	display/set program counter
.SR	display/set status register
.SS	display/set supervisor stack pointer
.US	display/set user stack pointer
DF	display formatted registers
OF	display offset registers
.R0–.R6	display/set offset registers
DC	convert decimal to hexadecimal
BF	block of memory fill
BM	block of memory move
BS	block of memory search
BT	block of memory test
BR	set a breakpoint
NOBR	remove breakpoint
GO, G	execute user program
GT	execute until breakpoint
GD	execute without setting breakpoints
TR, T	trace
TT	temporary breakpoint trace
DU	dump memory to a port
LO	load memory from a port
VE	verify memory load/dump
PA	printer attach
NOPA	reset printer attach
PF	port format
TM	transparent mode
*	send message

Table 1: *The commands available in the Tutor monitor.*

some uncommitted I/O (input/output) pins for a user to play with (see photo 1).

The MC68000L4 microprocessor in this kit is the slowest version Motorola makes of this chip, running at 4 MHz (compared to 12½ MHz for the fastest version). Remember: this board was designed for educators, not benchmark freaks. Yet even at this leisurely pace its minimum instruction time is only 1 microsecond. Because any given instruction on a 16-bit chip generally does a lot more than a single instruction on an 8-bit microprocessor, the throughput of a slow 16-bit chip is several times greater than that of the fastest 8-bit machine.

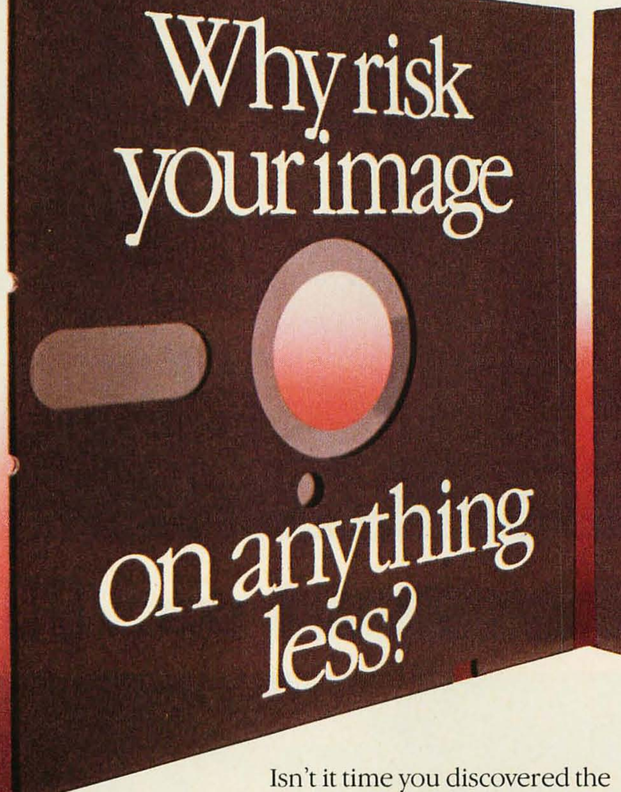
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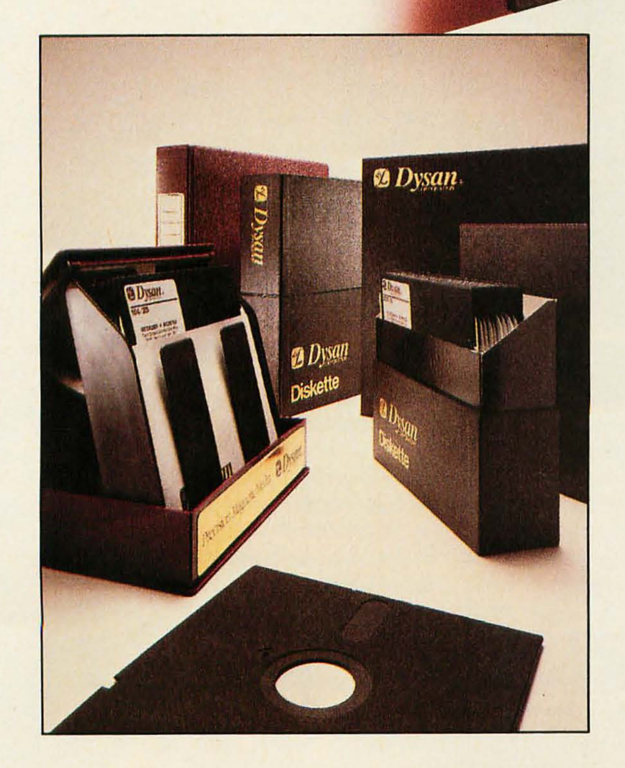
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The 32K bytes of RAM are located in the lowest memory space and consist of sixteen 16K by 1-bit dynamic RAM chips. The monitor program, which resides in two 8K by 8-bit ROMs, is located in address space 8000 to BFFF (hexadecimal), making it awkward to expand the RAM because any additional memory will be noncontiguous with the original RAM. (Because it should be no more difficult to have the monitor reside at higher memory, why not do so and give hobbyists more flexibility?)

Communication to the ECB is through one of its two RS-232C serial ports. The data rate is user-selected from 110 to 9600 bits per second. Although any RS-232C terminal can be used, a video terminal is definitely preferable. For example, if you are doing a program trace, displaying eighteen 32-bit registers can burn a lot of paper and time. Also, the assembler works by first disassembling an instruction, letting the programmer change it, then overwriting the original instruction with the new. This makes for a pretty messy display if you're using a teletype.

In addition to the transmit and receive lines (pins 2 and 3), serial port 1 must supply the DTR (data-terminal ready) signal. Pin 1 is not connected on the board, so make sure ground is tied to pin 7 on your DB-25 connector. The other serial port, the designated host port, allows the ECB to act like a terminal to a host computer, which enables programs to be downloaded from (or uploaded to) a host computer. The serial ports on the ECB come out to 20-pin edge connectors instead of to a DB-25 connector. If you don't want to make or modify your own cables, Motorola sells cables that mate from the edge connector to a standard DB-25.

The operation of the MC68230 PIT, a remarkable device in itself, requires a 32-page manual. The chip provides three 8-bit parallel ports with handshake and a 24-bit timer. Separate interrupt vectors for both the parallel ports and the timer may be stored in the PIT. This chip supports a Centronics-type parallel printer port (which drives my Epson MX-80) and provides a cassette-recorder interface.

In addition to the peripherals, you need a power supply for the ECB. The board requires only 5 volts at 750 milliamperes and +12 volts at 100 milliamperes. All the components are tied together on the board on a simple, unbuffered bus. Although there is no edge-of-board connector for system expansion, most of the 68000's pins are brought out to a wire-wrap area, and a provision exists for inserting a 50-pin connector for expansion by the user. Because these lines are unbuffered, three-state buffers should be installed if more than a couple of extra chips are added to the bus.

Software

The ECB contains a monitor in ROM called Tutor. In addition to the usual monitor functions, it provides a disassembler and a line-by-line assembler. Compared to what else is on the market, the monitor alone is worth

At a Glance

Name
M68000 Educational Computer Board (Motorola part # MEX68KECB)

Manufacturer
Motorola Inc.
Microsystems Division
3102 North 56th St.
Phoenix, AZ 85018
Distributed by Hamilton/Avnet Electronics

Hardware
Single-board computer, 6½ by 10½ inches, containing a 68000 microprocessor running at 4 MHz; 16K-byte monitor ROM; 32K-byte dynamic RAM; two serial I/O ports with data rate individually selectable from 110 to 9600 bps; MC68230 parallel port/timer that provides three 8-bit parallel ports with handshaking; audio cassette I/O; Centronics-type printer port; and wire-wrap area. Operation requires an external power supply (+5V at 750 mA, +12V at 100 mA), RS-232C-compatible video terminal, and connecting cable

Software
16K-byte monitor ROM with most of the functions of the Motorola Macsbug plus interpretative assembler, disassembler, printer and tape recorder functions, and a series of TRAP #14 functions that allows user program access to most of the monitor data conversion and I/O routines

Options
Interface cables to connect computer board to terminals, printers

Price
$495

Warranty
90-day warranty includes parts, labor, and return shipping

Documentation
Over 450 pages, including data sheets on LSI circuits, a software manual for the 68000, and a manual on the ECB hardware and monitor

Audience
Educators, students, hard-core hobbyists, and 68000 systems developers who would like to use the ECB as a supplementary aid

the price of the board. Table 1 lists the monitor commands provided in Tutor. Most of them resemble those of run-of-the-mill monitors, but a few require some explanation. Note the variety of addressing commands for Tutor. Most other monitor commands work only in the immediate mode (the user enters the explicit physical address), but Tutor has eight separate addressing modes. The most important of these are absolute, absolute plus the contents of an offset register, address register indirect, address register plus displacement indirect, and memory indirect.

One of the more sophisticated monitor commands is .Rn, which enables you to display and modify any of the eight special registers. Remember that the 68000 programs are intrinsically relocatable. These registers help users write position-independent code by being automatically added to addresses specified in Tutor commands. For example, it's generally easier to write assembly-language programs starting at an even address, such as 1000 hexadecimal. If you are following the book *68000 Assembly Language Programming* by Gerry Kane, Doug Hawkins, and Lance Leventhal (Berkeley, CA: Osborne/McGraw-Hill, 1981), you will notice that all the programs in the book start at 4000 hexadecimal. However, if more than one program is being used, the others have to reside somewhere else in memory.

Assigning the starting addresses of the routines to offset registers makes testing the routines a lot easier. Let's try an example. Assume you have a routine that starts at 4F7E hexadecimal and you'd like to test a piece of code hexadecimal 1A6 bytes from the origin. If adept at this sort of thing, you could perform hexadecimal arithmetic, come up with 5124, then type GO 5124. An easier way of doing this is to set R1=4F7E and then type GO R1+1A6 (or whatever displacement you need). The same technique is used for looking at the *n*th item of a buffer and checking the value in a peripheral chip.

The block search command (BS) lets you search through any block of memory looking for either ASCII (American National Standard Code for Information Interchange) strings or binary data. This is useful when looking for particular memory references, such as I/O locations. The block fill command (BF) is useful for zeroing memory or buffers or for setting ASCII buffers to all space characters. The GO command starts program execution at a specified location, but a return from subroutine (RTS) will not return to the monitor. To do so, you have to use a special TRAP instruction.

In transparent mode (TM), the ECB acts as a dumb terminal to a host computer. Everything received on port 1 is immediately transmitted on port 2. I was able to use the TM command to good advantage when installing the ECB in my Heath H-19 video terminal. Internally, I wired the output of the H-19 to the terminal port of the ECB, and the ECB's host port to the input of the H-19. When first powered on, the H-19 talks to the ECB; but once TM is executed, it behaves like a normal H-19.

DU (dump) and LO (load) commands let you dump automatically formatted binary files either to or from memory. Normally this command is used with port 4 for a tape recorder or with port 2 to a host computer. The VE (verify) command reloads a program saved using the DU command and verifies that it matches what is is in memory. The contents of memory can be either dumped or loaded using the DU and LO commands, respectively. Memory is dumped in what Motorola designates "S" records, which consist of header and data dumps in hexadecimal ASCII. You can use the DU command with all supported I/O channels (terminal, host, printer, and cassette tape). The LO command supports input from all but the printer. Because data is transferred in hexadecimal ASCII instead of straight binary, 2 bytes need to be saved for every single byte of actual data, which can be annoying when you have to wait two minutes to load a 4K-byte file.

Probably the two most important parts of the monitor are the assembler and disassembler. These features are

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004030    FFFF                  DC.W     $FFFF ?.

TUTOR  1.1 > MD 4000 2F;DI
004000    307C6000              MOVE.W   #24576,A0
004004    4280                  CLR.L    D0
004006    1018                  MOVE.B   (A0)+,D0
004008    6724                  BEQ.S    $00402E
00400A    43E80001              LEA.L    1(A0),A1
00400E    08810000              BCLR     #0,D1
004012    5340                  SUBQ.W   #1,D0
004014    600E                  BRA.S    $004024
004016    B308                  CMPM.B   (A0)+,(A1)+
004018    630A                  BLS.S    $004024
00401A    1420                  MOVE.B   -(A0),D2
00401C    10E1                  MOVE.B   -(A1),(A0)+
00401E    12C2                  MOVE.B   D2,(A1)+
004020    08C10000              BSET     #0,D1
004024    51C8FFF0              DBF.L    D0,$004016
004028    08010000              BTST     #0,D1
00402C    66D2                  BNE.S    $004000

TUTOR  1.1 > MM 402E;DI
00402E    4E73                  RTE      ? RTS_
```

Photo 2: *The assembly and disassembly functions, invoked by typing DI after a memory display or memory modify command. Assembly is done line by line—the code at the current memory is first disassembled and followed by a question mark. The programmer then types in the correct code, and the original code is overwritten with the new. Any value not recognized as a valid op code is disassembled as the declare word (DC.W) pseudo op.*

of much greater necessity than their counterparts on an 8-bit computer. Many times I've hand-assembled 100 or so lines of 6502 code, but I wouldn't even think of hand-assembling more than one line of 68000 code. Each instruction must be coded on a bit-by-bit basis, and the results must be converted to hexadecimal.

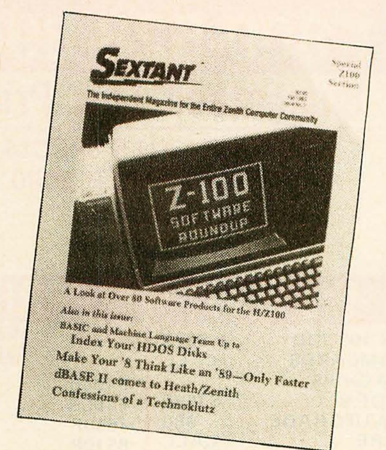
The assembler is a line-by-line interpretative routine, invoked by typing the MM (memory modify) command, the starting address, and the DI option. The assembler first disassembles the code at the current location, then prompts the programmer to enter the new instruction to be assembled. The new instruction is then written over the original. This process requires a video terminal because a printing terminal would type the new instruction over the old, resulting in illegible copy. Because it is a line-by-line assembler, labels can't be used in the operand field. Previously defined offsets, however, can be used. For forward references (address unknown), the * can be used. This generates the code for a jump to the location of the operation just assembled. When the entire routine has been written, it can be disassembled and the correct memory location inserted at all instructions that branch to themselves.

The disassembler may be invoked in the same manner as the assembler: it disassembles one line at a time. To get a complete listing, the MD (memory display) command can be used with the DI option (see photo 2). The listing can be directed to all four I/O ports. However, the

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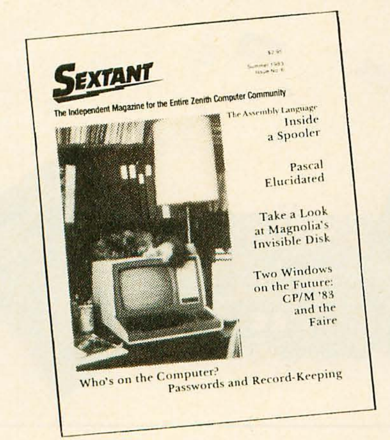
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software does not support reading anything other than "S" files from the tape recorder, and I have not yet found a way of retrieving disassembled listings from tape.

Motorola does not supply source listings of the Tutor program, which could be a pain for anyone writing I/O routines, but it does support a large number of user-available routines that can be accessed through the TRAP #14 instruction. The TRAP function is the only graceful way to enter supervisor mode from user mode. The function desired is passed as a parameter in register D7. Currently, 28 different I/O and utility routines are available to the user through the TRAP, and 127 additional numbers are available for user-defined functions.

Tutor is the only software available for the ECB. As dedicated software hackers get the board, this situation will change. I plan to purchase the FORTH source code for the 68000, along with the installation manual, from the FORTH Interest Group (FIG).

Documentation

When you first open the shipping container, the board seems dwarfed by the nearly 500 pages of documentation that come with the system (see photo 3). The documentation consists of a 240-page programming manual for the 68000, a 130-page manual for the educational board, and data booklets on the three major LSI (large-scale integration) chips on the board—the MC68000 microprocessor, the MC68230 parallel interface adapter and timer, and the MC6850 asynchronous communications interface.

I've read a lot of computer documentation and have found, as a rule, that Motorola documentation is the most thorough and intelligible. The documentation for the ECB is no exception. Only the source listing for Tutor is lacking. The documentation is not simple because the computer and its software are complex, but so far I haven't come across any problems that couldn't be solved by reading the book. Overall, the material reflects a standard of excellence I would like to see other manufacturers emulate.

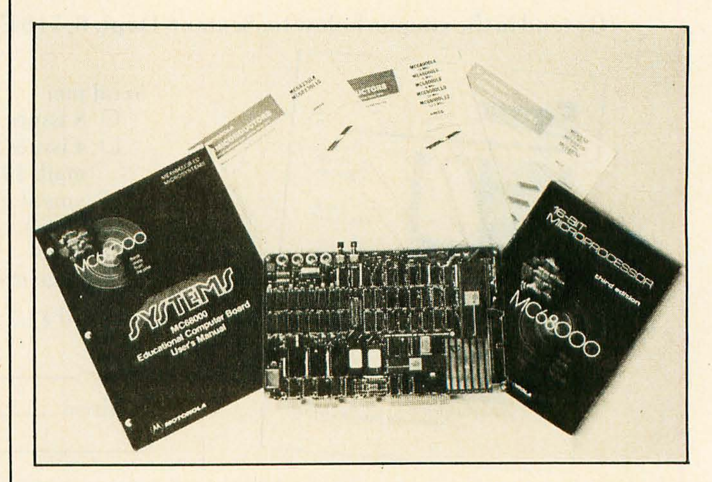


Photo 3: *The documentation seems to dwarf the ECB. Clockwise from left are the* Educational Computer Board Users' Manual, *data books on the MC68230 timer, the 68000, the MC6850 serial interface adapter, and the* MC68000 Programmer's Manual.

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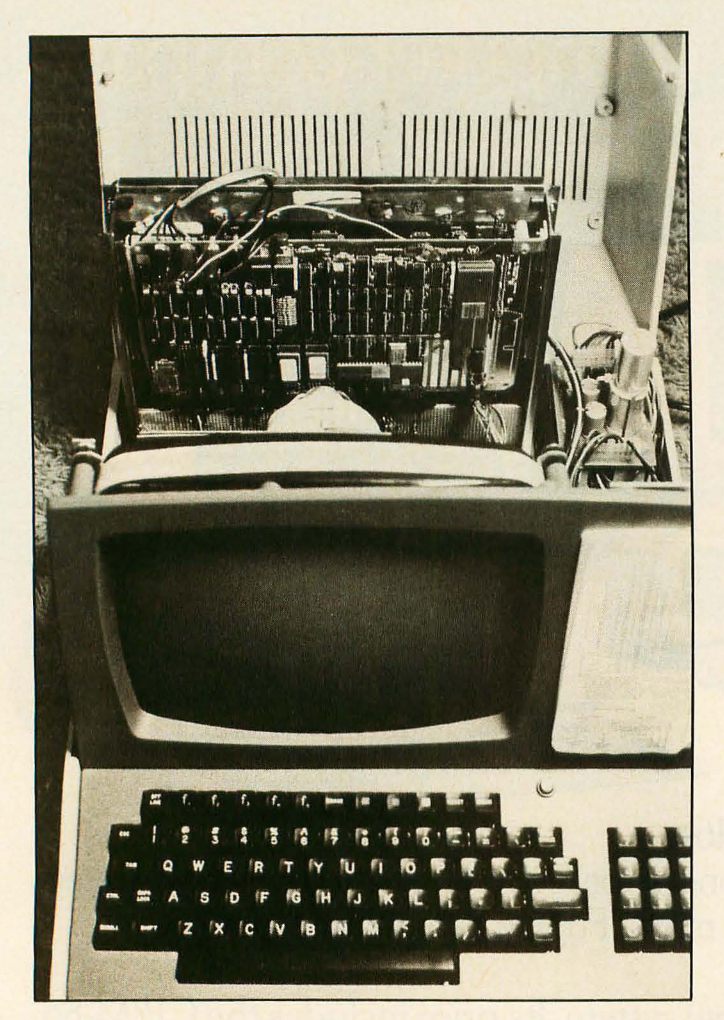


Photo 4: *The ECB fits neatly into a Heathkit H-19 terminal. Regulated power is obtained from the H-19 through the wires in the upper left. The serial output of the terminal goes directly to the ECB, and the host port of the ECB is wired to the serial output port of the H-19. Separate holes punched in the rear chassis are for the cassette and disk I/O connectors.*

Homebrew Capabilities

Although the board is designed primarily for educational purposes, it has great potential as the basis of a homebrew project. In fact, that was my prime motivation in buying the board. Because it starts out with an excellent monitor, 32K bytes of RAM, and some basic I/O functions, I was already on the way to having a system with reasonable capabilities.

I wanted video capabilities, so I installed the board inside a Heathkit H-19 terminal (see photo 4). The ECB draws only a few watts, thus there is no problem with it using the H-19 power supply. The serial output of the H-19 board goes directly into the ECB board, and port 2 of the board hooks to the DB-25 connector on the back. In this way, the system acts like a normal H-19 terminal when the program is in transparent mode.

Because I soon tired of loading programs from tape and had an old 8-inch disk drive I had picked up at a swap meet, I decided to construct a disk controller. The design I used is a modification of Nicholson and Camp's "Super Simple Floppy-Disk Interface" (see May 1981 BYTE, page 360). The interface turned out to be even simpler on the ECB because the 68000 is fast enough to perform some functions in software that had been implemented in hardware on the original design.

Conclusions

If you are interested in learning about the 68000, and particularly about 68000 assembly language, the ECB is hard to beat. Even if you already have a 68000 development system, the ECB is valuable for writing and testing short routines.

The monitor program alone, which includes an assembler and disassembler, is worth the price of the board. I expect a 16K-byte monitor to be very powerful, and this one is.

The Motorola documentation is excellent but lacks a source listing of the monitor program. However, most of the important I/O and conversion routines are available through the TRAP #14 function.■

Robert W. Floyd (1123 Kainui Dr., Kailua, HI 96734) works as a physicist at the Naval Ocean Systems Center, Hawaii Laboratory.


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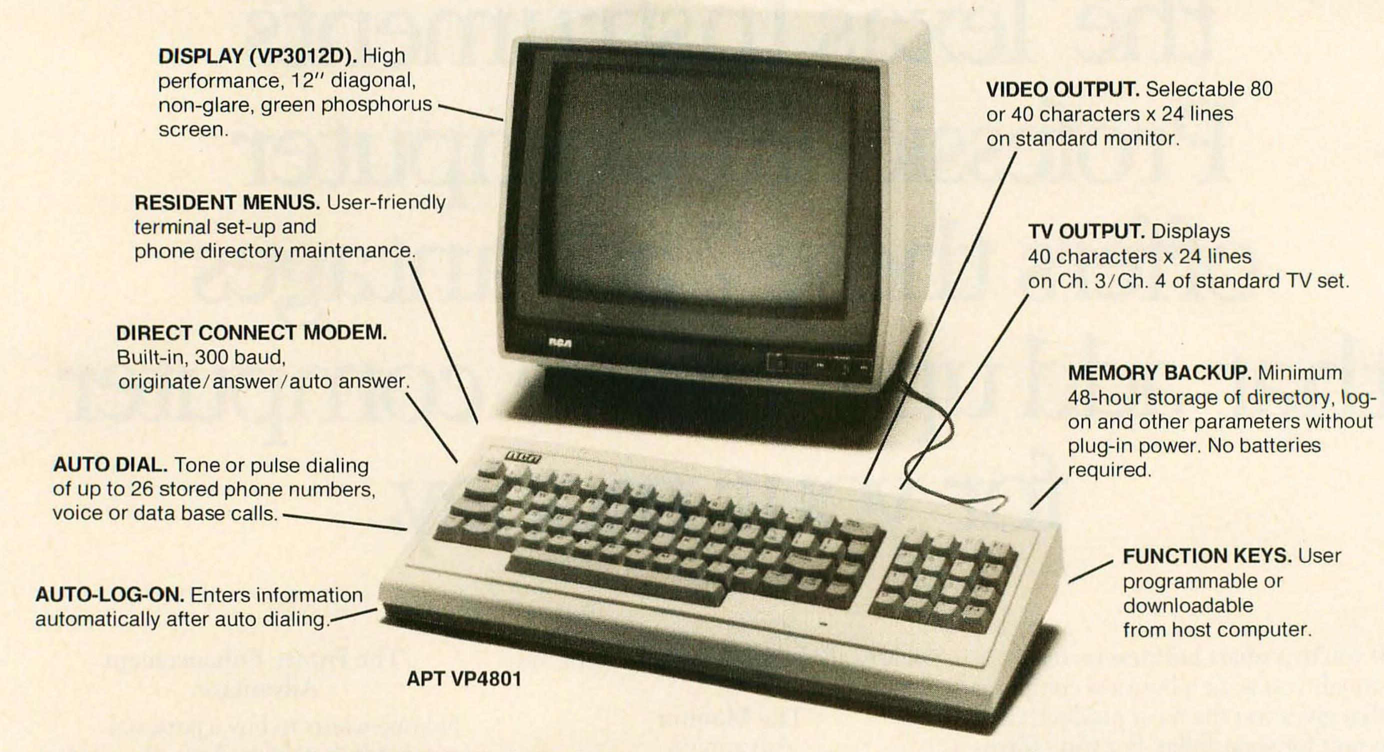
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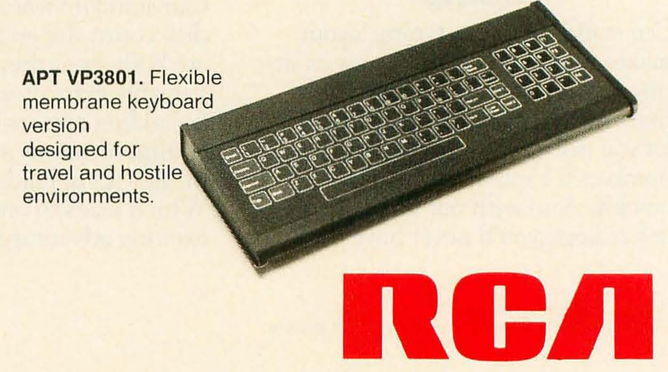
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Fancy Font

Increase the versatility of your Epson printer

by Paul E. Hoffman

Since before the age of wooden presses, typographers have been concerned with designing typefaces to suit specifications and tastes; that concern continues in this day of dot-matrix machines. Softcraft has released a program called Fancy Font that lets Epson printer users design their own type styles.

Epson printers, because they use dot-addressable graphics, are capable of considerable versatility; however, modifying your own program to directly control each pin in the Epson's print head is a difficult and time-consuming task.

With the Fancy Font system, you can alter the size and style of characters and create unique symbols. This easy-to-use package runs under CP/M-80 or PC-DOS and works with any MX-80, MX-100, FX-80, or FX-100 printer. (The MX series must have Graftrax graphics chips; all FX printers come with the Graftrax installed.) With just a few additions to your text files, you can print in roman, italic, sans serif, Old English, script, or a font of your own design.

Fancy Font achieves a very high quality print by using the Epson's dot-addressable characteristics—it prints the necessary dots for each line, moves down a fraction of a dot-width, prints the line again, and so on, six passes per line. Although this procedure makes printing your final draft quite slow, the output is significantly more attractive than the standard type style available.

The people at Softcraft have apparently gone to great lengths to make Fancy Font a usable program; they've packaged extensive command-line options, help messages at all prompts, informative error messages, and, most important, a complete and well-written users manual for $180. The market for Fancy Font includes anyone with a CP/M-80 or PC-DOS machine and an Epson printer who wants a variety of type styles.

Style	Sizes
Roman regular	8, 10, 11, 12, 18, 40
Roman italic	10, 11, 12, 18
Roman bold	10, 11, 12, 18
Roman subscript	8
Roman superscript	8
Sans serif regular	8, 10, 11, 12, 18
Sans serif italic	12
Old English	18, 20, 40
Script	12, 14, 18, 20, 40
Special characters	12, 20, 40

Table 1: *Sizes of fonts supplied with Fancy Font. All sizes are given in points; 1 point is equal to 1/72 of an inch.*

Features of Fancy Font

Fancy Font, loaded with features, lets you customize output to fit your needs. As a result, you can actually come up with new uses, instead of a list of wishes, for the system. This flexibility is important to anyone who uses a computer for different applications.

One of the package's most apparent features is the number of predefined fonts it offers. The 33 font files (see table 1) provide enough latitude that you will probably never need to define your own font. The fonts are very well designed and resemble closely the type from a standard typesetter; examples of each font are shown in figure 1.

You can have as many as 10 fonts active at any one

These are Roman regular, *Roman italic, and* **Roman bold.**
Many people prefer the Sans Serif regular or *Sans Serif italic,*
but the most proper and high-minded among us prefer Script or even
Old English.

Figure 1: *Samples of the type styles provided with Fancy Font.*

time. Fancy Font tries to load into memory as many fonts as possible in order to reduce disk access time, but it will swap fonts in and out of memory as necessary. You probably won't use more than three or four type styles in any one document, but you might have many files with the special symbols and characters you create, and you may want to use different sizes of one style for things such as headings, body, and footnotes.

You need to make only minor modifications to your current text files to accommodate Fancy Font. All formatting commands are given with a backslash and can be inserted in-line. The commands let you space vertically on the page with accuracy to 1/72 of an inch, space horizontally with accuracy to 1/120 of an inch, justify text, substitute strings specified on the command line, and a host of other functions (see table 2).

Tables are especially easy to format with Fancy Font because you can specify both relative movements (from your position on the page) or absolute movements (from the top or left margin).

Command	Description
fn	Switch to font number n
vn	Move down n/72 inches
wn	Move to n/72 inches from the top of page
h	Move right by 1/120 of an inch
in	Move right n/120 inches
an	Move to n/120 inches from the left margin
p (or ^ L)	Go to next top of page
t (or ^ I)	Move to next tab stop
u	Toggle underlining
c	Center the current line
r	Make the current line flush right
b	Break the current line
j	Turn on justification
k	Turn off justification
dn	Print ASCII character n
sn	Substitute string number n
s#	Substitute the current page number
sf	Substitute the current filename

Table 2: *Formatting commands in Fancy Font. These commands may appear anywhere on a line of text. They are all preceded by a backslash (e.g., \c).*

Because Fancy Font works with any text editor, you can type in the text you want to print, then add the formatting commands afterward. Unfortunately, Fancy Font does not format paragraphs, so each line has to be the right length; however, with the justification command, there is a reasonable amount of leeway. Many text editors let you set the margins for their own paragraph filling; you can simply adjust these to the ones you choose in your Fancy Font output.

People rarely agree on how they like their text to look, so Softcraft has included an editor that lets you change the characters provided. Though it's not quite as easy to use as the formatting program, the new user can pick it up fairly quickly. The program lets you modify existing fonts and create your own. Figure 2 shows three letters as they appear on the distribution disk and after modification using Fancy Font. It took less than two minutes to make the changes. To modify characters, you choose a character set for the originals and instruct Fancy Font to save each character as a file of asterisks, each asterisk representing a dot to be printed. You then edit each file, asterisk by asterisk, shaping the letters to your preference; for example, you can add asterisks to make characters bolder or wider and remove asterisks to make characters lighter or more narrow.

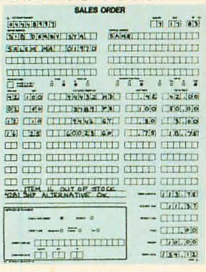
You may want to create special characters that do not correspond to ASCII (American National Standard Code for Information Interchange) codes. The Fancy Font system contains a program called Cfont that lets you select characters from the Hershey set, a collection of graphics symbols and letters, and insert them in your own fonts. Of course, you can also modify these characters the same way you modify the ASCII characters.

Figure 3 shows an AND gate in a shaded box and the input to the formatter that made the figure. The gate was created with a text editor, and the shaded box was supplied as a combination of the characters in one of the special fonts. In font 0 (the supplied special-character font), b makes the vertical line and g makes the box. In font 1 (created with the electronic symbols), A generates the AND gate.

With the Hershey set's four type styles and almost 1600 symbols (including Greek, Hebrew, and Russian characters), you may think you have all the printing characters you would ever want. One of the nicest features of Fancy Font is that its writers knew this would not be the case and that you would want an easy way to create your own characters.

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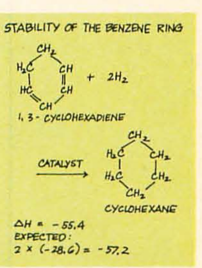
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Before Fancy Font begins formatting your text, you can give commands that set margins, substitute strings, and print the copy you need. You can give these parameters (see table 3) on the CP/M or PC-DOS command line, have them stored in the PFONT command file for repetitive use of the formatter, or enter them interactively.

The interactive input for these parameters is especially easy to use; every software company should be as helpful in guiding users as Softcraft is. At any prompt, you can type a ? to get more information about what your options are at that point. You can also type a & to find out all of the current values, a < and a filename (a la Unix) to get more parameter commands from a command file, a Control-V to get a general help message, or a Control-C to quit (the system asks if you are sure before tossing you back to the operating system).

While your file is printing, you can abort the printing of an individual page by typing a Control-P, abort the rest of the current file by typing a Control-F, or abort printing completely by typing a Control-C. Perhaps this seems like an excessive number of features, but once you start using Fancy Font you will probably want them all.

Disadvantages

Fancy Font is a very useful program; however, it has two disadvantages. First, because the program requires six passes over each line (and prevents the printer from running bidirectionally), it takes an incredibly long time to print anything. Second, the formatter does not know

> ## At a Glance
>
> **Name**
> Fancy Font version 1.7
>
> **Type**
> Text formatter for enhanced printing with Epson printers
>
> **Manufacturer**
> Softcraft
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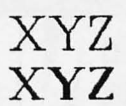


Figure 2: *The top line shows characters from the distribution disk. The bottom line shows those characters modified using Fancy Font.*



\ f0bgb \ a0003 \ f1A

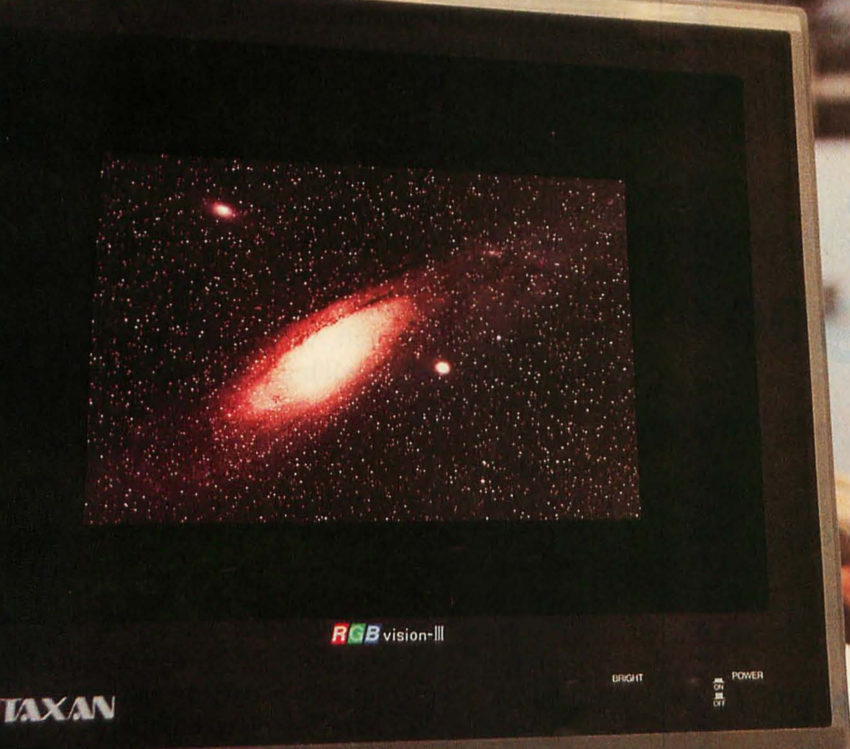
Figure 3: *An AND gate in a shaded box and the line of text used to produce it. The AND gate was designed with a text editor and made part of a font of electronic symbols.*

Command	Description
FI	Name of file(s) to print; up to 15 may be specified
FO	Name of fonts to use; up to 10 may be specified
RD	Rough draft mode; this allows two faster, but lower-quality, print modes
EP	Use normal Epson fonts, including compressed, expanded, double-strike, etc.
SD	Screen display
SU	Strings to substitute for
FP	First page to print
LP	Last page to print
CF	Concatenate files without a page break
LM	Left margin
SP	Spacing between lines
TM	Top margin (between page top and text)
BM	Bottom margin (between text and page bottom)
HM	Heading margin (between page top and header)
FM	Footing margin (between footer and page bottom)
PL	Total page length in inches
LW	Line width
HL	Heading line for top of page
FL	Footing line for bottom of page
NF	Suppress header and footer on first page
PP	Pause between pages for paper insertion
PF	Process formfeeds
PN	Initial page number
CI	Change command indicator
IS	Set initialization string
PG	Enable vertical margins
TB	Set tab stops

Table 3: *Parameters to the PFONT command.*

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how to wrap paragraphs; the lines in your input file must be the correct length when you run the formatter.

The lack of paragraph wrap is a program deficiency I hope will be rectified in future releases of Fancy Font. Although Softcraft claims you can generally guess the correct line length, you will more than likely need to go through two rough drafts to get the line lengths right. It would be much handier for Softcraft to simply figure out how many characters can fit on a line (accounting for differences in character sizes) and break the line at the nearest word.

The slow printing speed is necessary for Fancy Font to produce high-quality type. To partially alleviate this problem, Softcraft gives you three choices of type for rough drafts: two lower-density print modes and the straightforward Epson typeface. You can look at rough drafts of your work, then print out the final copy later. The two rough-draft modes run about three and four times faster than the final draft mode but about half as fast as the Epson font mode. In the high-quality mode, it takes 10 to 15 minutes to type an average page of text.

Documentation

As you would expect from a program with an excellent user interface, the manual is clear and easy to read. The text begins with an example of how to start printing with Fancy Font and explains all options and parameters in detail.

The nine appendixes cover everything from using Fancy Font with Wordstar to the internal formats of the font files. They also show samples of the different type styles and all of the characters in the Hershey set. The back cover serves as a reference card for the formatter parameters and options.

The people at Softcraft, very responsive on the telephone, are more than willing to answer detailed technical questions.

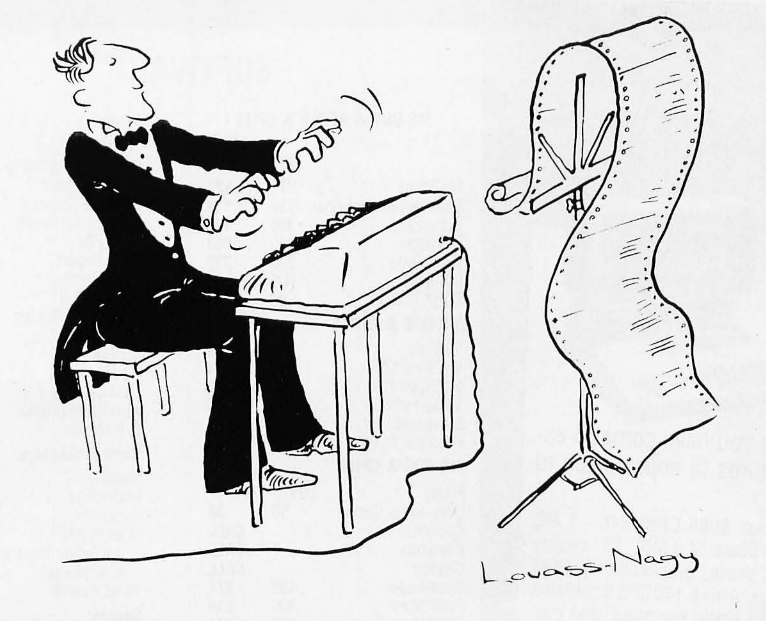
Conclusions

Fancy Font will give your CP/M-80 or PC-DOS computer a new way to present text. The system's resolution is quite good (it can be improved by reducing the printed output with a photocopier), and the program is very easy to learn and use.

Although the final output takes a significantly long time to print, its high quality is usually worth the wait. Also, being able to design your own characters and symbols frees you from having to cut and paste them on printed pages.

The number of Fancy Font's print features is impressive. For anyone with an Epson printer, Fancy Font's ease of use makes it a package worth considering. The price of the package is fair compared to others on the market, and its capabilities make it a very good buy.■

Paul E. Hoffman, president of Proper Software (Suite 1024, 2000 Center St., Berkeley, CA 94704), writes manuals for many microcomputer companies in the San Francisco area.



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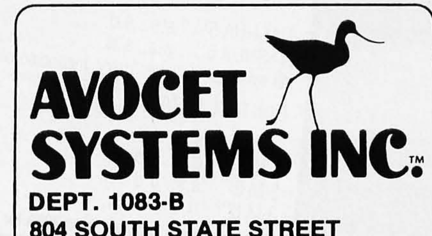
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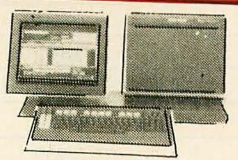
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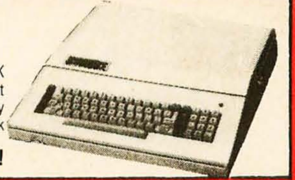
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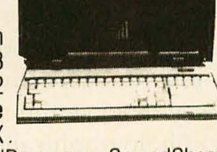
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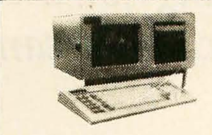
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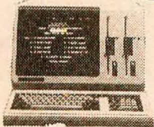


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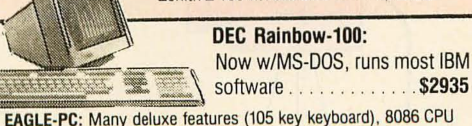
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Photographic Animation of Microcomputer Graphics

By compensating for a computer's slow rate of display generation, a movie camera can produce pleasing animated graphics

by Peter Cann

A computer's ability to generate pictorial displays opens the door to many exciting applications, but most computers can't achieve the animation quality of commercial movies or TV. Interfacing a movie camera to a computer, however, can overcome this drawback.

The inability of most computers to achieve TV-quality animation stems from their video-display generation rates. These low rates prevent a computer from generating the successive, slightly different images quickly enough to create the illusion of continuous motion as perceived by the human eye. For example, simulating a piece of TV footage in real time (requiring 60 frames per second) is a challenge beyond the capability of any ordinary computer.

The phrase "in real time" in the preceding paragraph is significant. Without it, the sentence it qualifies would be false. For in terms of resolution, many computers can generate images showing much more detail than can broadcast TV, even though these computers might not be able to flash a new frame on the screen every 1/24 or 1/60 second, as can movie and TV equipment, respectively.

One way to solve the speed problem is to photographically animate a computer's visual output. This technique allows a computer to take as much time as it needs to generate each frame. When the computer completes one frame, a movie camera, whose shutter is triggered electronically by the computer, transfers that image to a single frame of film and then advances the film by one frame. The computer then begins to draw the next frame. When it finishes, the camera records that frame and again advances its film one frame. When the entire presentation has been captured one frame at a time in this manner, the film is developed and shown at sufficient speeds to be of interest to people.

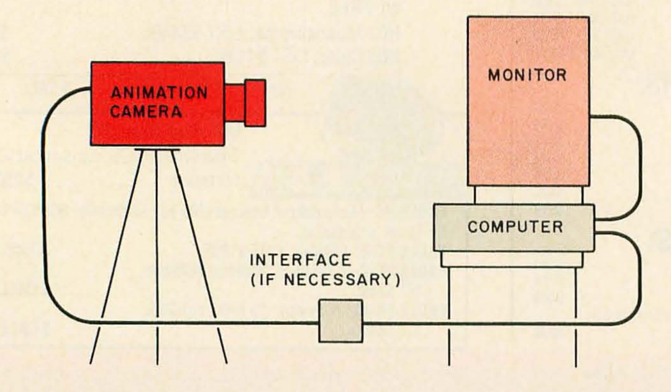
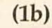


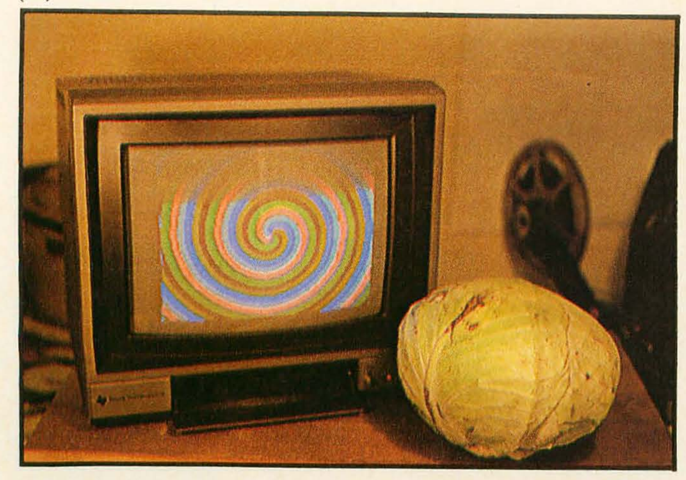
Figure 1: *A system block diagram. In this configuration, the animation camera is focused on the monitor, which in turn receives and displays the computer's video output. The camera's trigger circuit is interfaced to the computer.*

Effective use of this technique requires an understanding of the factors that affect still photography of video images, such as exposure timing, ambient light, and the alignment of the camera with the screen. For all but the briefest presentations, it is almost imperative to have the camera controlled by the computer (see figure 1).

This article offers various tips for those interested in still or stop-action photography of video displays. Along with explanations and suggestions of a general nature, I will present examples, including programs and camera-control interfaces, for the TI-99/4 and Apple II computers.



(1a)



(1b)



Photo 1: *Video display and cabbage. Photo 1a shows that bright external light and a brief (1/125 second) exposure are good for the cabbage but bad for the video display. Photo 1b, in contrast, shows that no external light and a long (1/2 second) exposure are great for video display—but where's the cabbage?*

Shooting Video

Photographing a TV picture is not the same as photographing, say, a cabbage (see photo 1). The TV image is created by an electron beam of varying intensity that scans across the phosphor-coated screen at high speed. The phosphor glows where the beam hits it, with a brightness related to the beam's intensity. The beam scans one horizontal line every 60 microseconds or so, generating a complete frame every 1/60 second.

A photograph of a TV screen exposed for less than 1/60 second comes out with parts of the picture much darker than the rest (see photo 2a). These parts may not be completely black because the phosphor continues to glow dimly for a short time after the electron beam stops striking it. An exposure slightly longer than 1/60 second results in parts of the picture being somewhat brighter than the rest (see photo 2b); the bright parts were scanned twice during the exposure while the rest of the picture was scanned only once.

Any exposure that is an exact multiple of 1/60 second should provide an excellent picture, but camera timing accuracy must be better than ± 1 percent for the lower multiples—for example, 2/60 or 3/60 second. The few cameras whose timing accuracies I have observed have not met this requirement (see photo 2c).

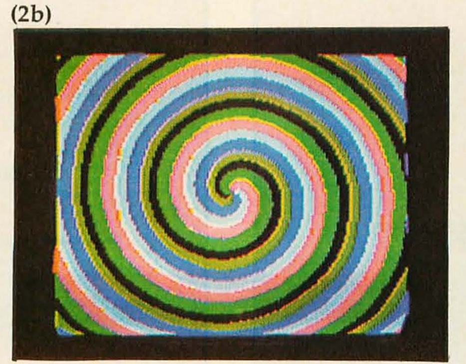
One good way to photograph an unchanging TV image is with a very long exposure. Because each dot is generally scanned either n or $n+1$ times during an exposure, you can simply make n great enough so that the difference between the two possibilities is insignificant. I recommend something like 1/2 second, which entails about 30 video scans. Anything shorter than 1/15 second results in noticeable image degradation due to timing effects.

These timing problems are much less serious if a monitor with a high-persistence phosphor is used. The persistence of a phosphor is a measure of how long a piece of it glows after being momentarily excited by an electron beam. The phosphor used in most green-screen monitors has much higher persistence than that found on TV.

Another threat to picture quality is stray light. Unlike the cabbage, which we see by means of the light it reflects, the TV picture is luminous. It makes its own light, and any light striking it from outside only washes

(2a)

(2b)



(2c)

Photo 2: *Video-display photographs illustrating the effects of camera timing. The 1/125-second exposure used to take photo 2a was too brief to record a whole frame. The shutter opened while the middle of the screen was being scanned and closed before the electron beam returned to the top of the screen. Note that the phosphor near the top was still glowing during the exposure even though the electron beam had passed on. In taking photo 2b, the timing control was set between 1/60 and 1/30 second; thus, some screen areas were scanned twice while the shutter was open, some only once. To take photo 2c, the camera was set for a 1/30-second exposure. Every part of the screen should have been scanned exactly twice while the shutter was open. Unfortunately, the camera's timing mechanism is not sufficiently precise for this purpose.*

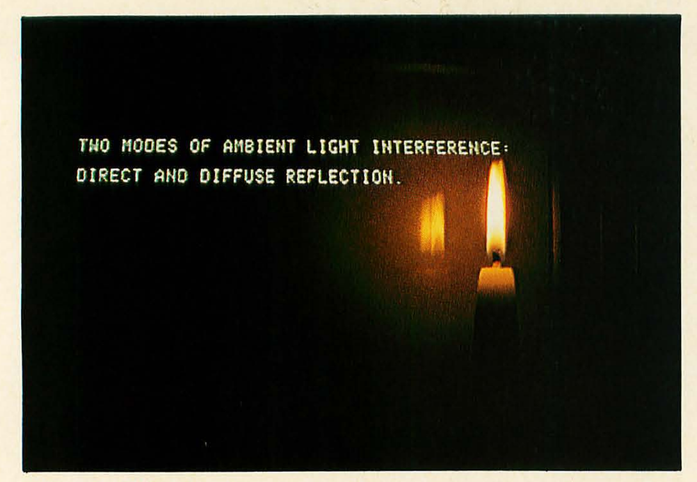


Photo 3: *Video display with candle, resulting in two sharp reflections of the candle's flame: one from the front surface of the glass screen and another from the back surface. Light from the flame also scatters back from the phosphor in all directions.*

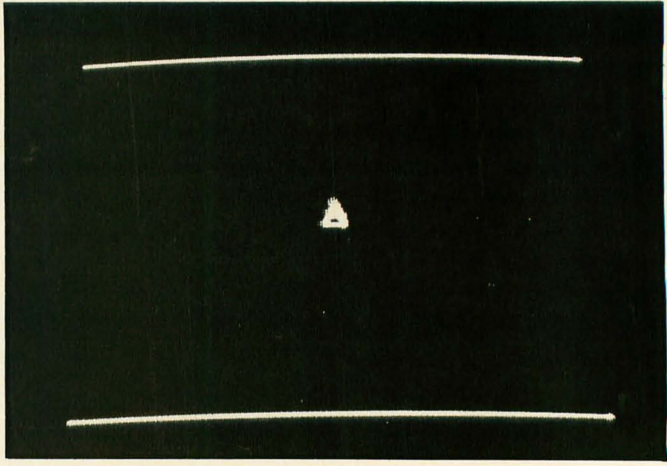


Photo 4: *This photo indicates parallax effects. Although the two lines shown here are of equal length on the computer monitor, the lower one looks longer because the camera was positioned below the monitor, looking up at an angle of about 45 degrees.*

out the picture. This problem manifests itself in two modes: some light may bounce from the surface of the glass as if from a mirror, while other light may scatter back from the light-gray phosphor inside (see photo 3). Cue lights on the front of the camera should not be overlooked as a source of such interference. For example, the jumbo red LED (light-emitting diode) on the front of our animation camera at Logo Computer Systems Inc. (LCSI) bounced light off the surface of the screen and into the lens, showing up on the film. To prevent image degradation due to this light, we usually covered the LED with tape.

One last point: if the camera is not aligned squarely with the screen, parallax distortion occurs. For example, if two parallel lines of equal length are displayed on the screen, and the part of the screen containing one line is closer to the camera than the part containing the other, the closer line will appear longer on the film (see photo 4).

The Animation Camera

At LCSI we used a Canon 1014 XL-S camera for animation. This Super-8 camera with single-frame capability and electronic remote control (see photo 5) offers three film speeds: 9, 18, and 24 frames per second, as set by the film-speed knob. In run mode these film speeds result in approximate exposure times of 1/15, 1/30, and 1/60 second, respectively. The 1/15-second exposure works pretty well for shooting video images.

With the camera in single-frame mode, the film-speed knob continues to control exposure time. Unfortunately, the 9-frames-per-second position now gives a 1/30-second exposure. This setting produces an unsatisfactory picture with flickering diagonal stripes resulting from interaction of the camera's rotating slotted-disk shutter with the video scan.

While playing with the camera, we discovered that it would shoot a single frame at 1/15 second if we put it in the 9-frames-per-second run mode and closed the camera's trigger circuit for 1/3 second. (It seems likely that many cameras without a single-frame mode could be convinced to shoot single frames by using this method. Even the old windup movie cameras could prob-





Photo 5: *Two views of the Canon 1014 XL-S animation camera.*

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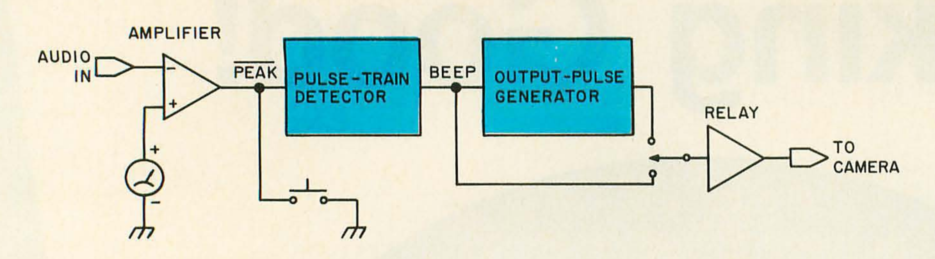


Figure 2: *A block diagram of the TI-99/4A interface. The audio signal is amplified and fed to a detection circuit, which provides a digital output indicating whether a tone is present. Pressing the push button simulates a tone. A tone-presence signal BEEP is fed to the output-pulse generator. Pulses are triggered by the falling edge of BEEP. The relay can be driven by the output-pulse generator or directly from BEEP or it can be left unconnected.*

ably be controlled this way if you could devise an electromagnetic actuator for the trigger.)

Interfacing

I was originally retained by LCSI to develop an interface to permit a TI-99/4 computer to control a Super-8 animation camera under control of the TI Logo language. The interface was to be used in the production of an experimental animated movie.

I decided to control my TI-to-camera interface with the audio output of the 99/4, which is usually plugged into the monitor. TI Logo supports the generation of a 1/2-volt (V), 400-Hz square wave at this output. The duration of the camera triggering pulse could have been controlled by a WAIT <time> instruction in the software, but there seemed to be some risk that Logo housekeeping operations, known as garbage collections, might occasionally occur during the pulse, extending it and causing the camera to shoot a number of frames when only one was wanted. In view of this possible problem, my interface provides a hardware-timed contact closure that is triggered for a single pulse every time the audio signal goes away (see figure 2).

In the interface the audio input is continuously compared to a threshold voltage selected to be slightly less than the peak audio voltage. The comparison result NOT-PEAK is normally high (+9 V), going low (0 V) whenever the audio level exceeds the threshold level or whenever the push button is pressed. The retriggerable one-shot output BEEP is high if—and only if—its input was low within the previous 1/100 second—in other words, during the BEEP or while the button is being pressed. The output-pulse generator is triggered on the falling edge of BEEP. A three-position toggle switch allows connection of the output-relay coil to the output-pulse generator, nothing, or BEEP. The center (open) position is useful for preventing a power-on glitch from firing the camera.

Figure 3 shows the TI-99/4-interface schematic diagram. In this circuit the audio signal runs through a 6-kHz low-pass filter made up of R1 and C1 to remove high-frequency noise. It is

Figure 3: *A schematic diagram of the TI-99/4 interface.*

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then AC-coupled to the inverting input of the LM741C op amp through C2. This input is biased at +2.5 V by the voltage divider consisting of R2 and R3. The noninverting input of the op amp is tied to a voltage in the range of +2.5 to +3.6 V by the adjustable voltage divider consisting of R4, R5, and R6. The exact voltage is selected by experiment.

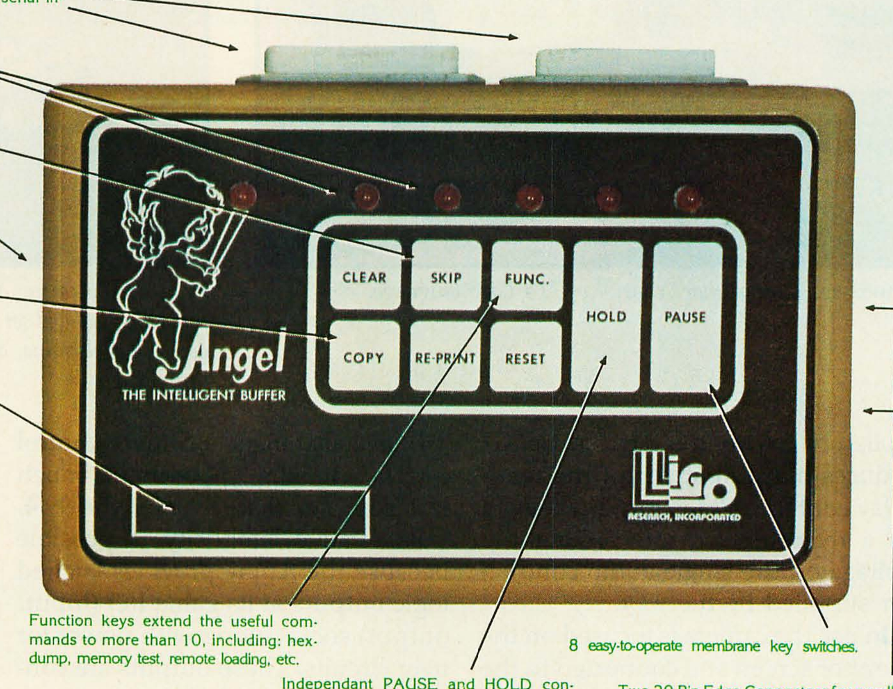
The output of the op amp is filtered by the R7–C3 combination. Diode D1 provides the desired fast-discharge, slow-charge action. Push button PB1, when pressed, holds C3 in the discharged state, duplicating the effect of the audio-beep signal. The voltage across C3 is interpreted by one of the twin 555-type timers in the LM556 chip. This half of the chip is configured as an inverter with hysteresis. Trip points at the input are 1/3 and 2/3 of the supply voltage. Including R7, C3, and D1, this circuit can be called a retriggerable one-shot.

The retriggerable one-shot output (LM556 pin 5) is made available to SW2 (mode select) and is coupled to the output-pulse-generator trigger input (LM556 pin 8) through the C4–R8 high-pass filter. Diode D2 protects this input from the +18-V spike created by the rising edge of the one-shot's output. The time constant for the output-pulse generator equals (R9+R10)C5, R10 added to avoid the possibility of a short circuit at low settings of R9.

SW2 connects the reed-relay coil to LM556 pin 5 (direct mode), nothing (safe mode), or LM556 pin 9 (pulse mode). Freewheeling diode D3 kills spikes created when the reed-relay coil is deenergized, and ballast resistor R11 reduces the load on the pulse-generator output (LM556 pin 9) sufficiently to ensure proper operation when SW2 is in pulse mode. (Adding R11 shouldn't be necessary; a healthy LM556 chip should be able to function while supplying up to 200 milliamperes to the relay. The interface that I built, however, couldn't end the output pulse until I installed the resistor. Other solutions might involve more careful layout or increased use of filter capacitors on the power lines.)

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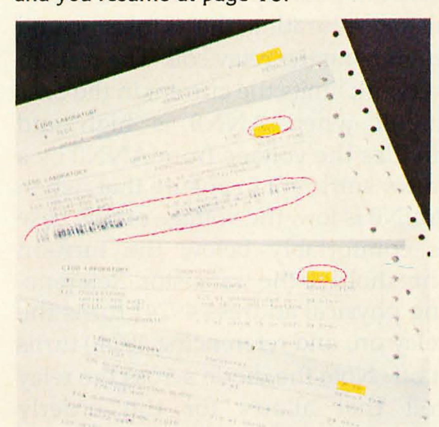
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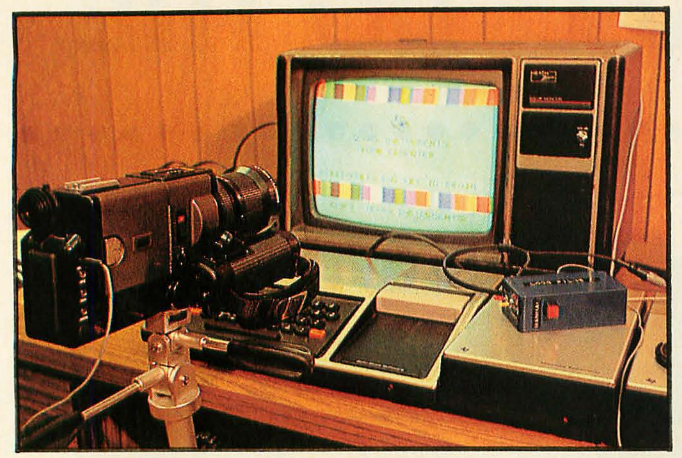


Photo 6: *Filming under control of TI's Logo language.*

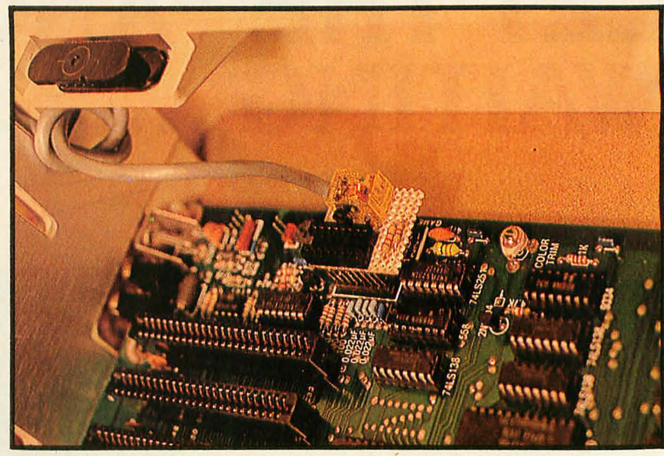


Photo 7: *For a few dollars, this interface lets the Apple computer control an isolated set of contacts, which can control cameras, cassette decks, model trains, and other items. Game paddles can be plugged in on top.*

trolled by SW1 and filtered by C6. C7 reduces harmful arcing of the reed-relay contacts. Video ground is used as a reference for interpreting the voltage on the single audio conductor supplied by the 99/4.

In use the camera is focused on the monitor screen and connected to the interface (see photo 6). The interface accepts the 99/4's audio and video plugs and provides a video plug to the monitor. The video plug is involved because the 99/4 has only one wire going to the audio plug; the interface, like the monitor, uses video ground as a reference for interpreting the audio signal.

I have also made a camera-control interface for the Apple that is much less complex than that for the 99/4. This relative simplicity is possible because the Apple provides latched logic outputs at its game I/O (input/output) socket along with power for user circuits. These outputs are controlled by referencing certain physical-memory addresses. The various Logo implementations for the Apple support this output control with .DEPOSIT <address> <value> and .EXAMINE <address> commands. They also provide a means of forcing a garbage collection, which prevents arbitrary garbage collections from popping up for a little while, allowing generation of an accurate delay with a software loop.

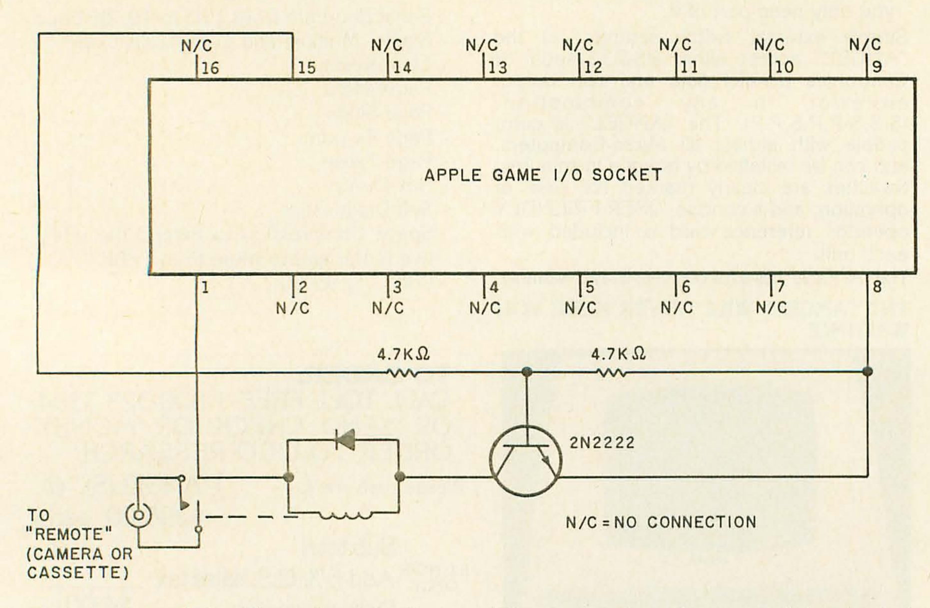


Figure 4: *Apple-interface schematic diagram. The Annunciator 0 output of the Apple is amplified by the transistor and used to control the relay. The resistors protect the Apple and the transistor and ensure that the transistor turns off when it should. The diode allows the relay's coil current to decay gradually when the transistor turns off.*

The Apple interface consists of a relay driven by a transistor that is in turn driven by the Apple's Annunciator 0 (ANN0) output. The circuit is constructed on a vector board with a 16-pin wire-wrapping socket used as a plug to mate with the Apple's game I/O socket (see photo 7). Using the wire-wrapping socket is an easy way to allow things to be plugged in on top of the interface. If you feel uncomfortable about forcing the wire-wrapping pins into the Apple's socket, you can use a 16-pin header. This interface can be used without modification to control a cassette-deck motor.

The device to be controlled is connected to the normally open contacts of the relay (see figure 4). When ANN0 (pin 15) goes high, the resistor network pulls up the base of the transistor, saturating the transistor and energizing the relay coil. The resistor network limits the current in the base circuit when ANN0 is high and divides the voltage from ANN0 by a factor sufficient to ensure that, when ANN0 is low, the voltage on the base is comfortably below the turn-on threshold of the transistor. Referencing physical address 49241 turns the relay on, and referencing 49240 turns it off. Note the diode across the relay coil that allows for the orderly disposal of energy stored in the coil's magnetic field. Without the diode, a

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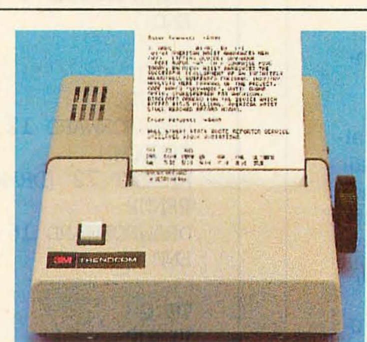
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voltage many times greater than the supply voltage could appear across the transistor when the transistor tries to interrupt the current in the relay coil.

On machines already equipped with a software-controllable cassette-motor relay, the Remote cord can be plugged directly into the 1014 XL-S camera. Such a direct connection should also work with machines that use a transistor to control the cassette motor if the wiring is such that the camera's control-circuit current can flow through the transistor in the appropriate direction.

Listing 1: *TI Logo procedures used to generate an animated film, frames of which appear in photo 8.*

```
TO ACTION
TELL TURTLE
CLEARSCREEN
HIDETURTLE
COLORBACKGROUND 1
SETCOLOR 15
SX - 80
SY 30
SETHEADING 90
L
O
G
O
NOPENCIL
REPEAT 24 [SHOOT]
SIGNAL
END

TO L
PENDOWN
RIGHT 90
DRAWFORWARD 24
LEFT 90
DRAWFORWARD 16
PENUP
LEFT 90
DRAWFORWARD 24
RIGHT 90
DRAWFORWARD 4
END

TO O
PENUP
DRAWFORWARD 12
PENDOWN
REPEAT 72 [DRAWFORWARD 1 RIGHT 5]
PENUP
DRAWFORWARD 16
END

TO G
PENUP
DRAWFORWARD 12
REPEAT 9 [DRAWFORWARD 1 RIGHT 5]
RIGHT 180
PENDOWN
REPEAT 63 [DRAWFORWARD 1 LEFT 5]
LEFT 90
DRAWFORWARD 12
PENUP
RIGHT 90
DRAWFORWARD 12
RIGHT 90
DRAWFORWARD 16
END

TO DRAWFORWARD :STEPS
IF :STEPS = 0 THEN STOP
FORWARD 1
BUILDPENCIL
SHOOT
DRAWFORWARD ( :STEPS - 1 )
END

TO BUILDPENCIL
MAKE "X ( XCOR - 7 )
MAKE "Y YCOR
TELL SPRITE 0
SETCOLOR 4
SY ( :Y + 4 )
SX :X
CARRY 0
TELL SPRITE 1
SETCOLOR 11
SY ( :Y + 12 )
SX :X
CARRY 1
TELL [2 3]
SETCOLOR 3
SY ( :Y + 28 )
SX :X
CARRY 2
TELL SPRITE 3
SY ( :Y + 44 )
TELL SPRITE 4
SETCOLOR 6
SY ( :Y + 60 )
SX :X
CARRY 3
TELL TURTLE
HIDETURTLE
END

TO SHOOT
BEEP
WAIT 10
NOBEEP
WAIT 60
END

TO NOPENCIL
TELL [0 1 2 3 4]
SETCOLOR 0
END

TO SIGNAL
COLORBACKGROUND 15
PRINT [ALL DONE.]
WAIT 60
COLORBACKGROUND 1
WAIT 30
SIGNAL
END
```

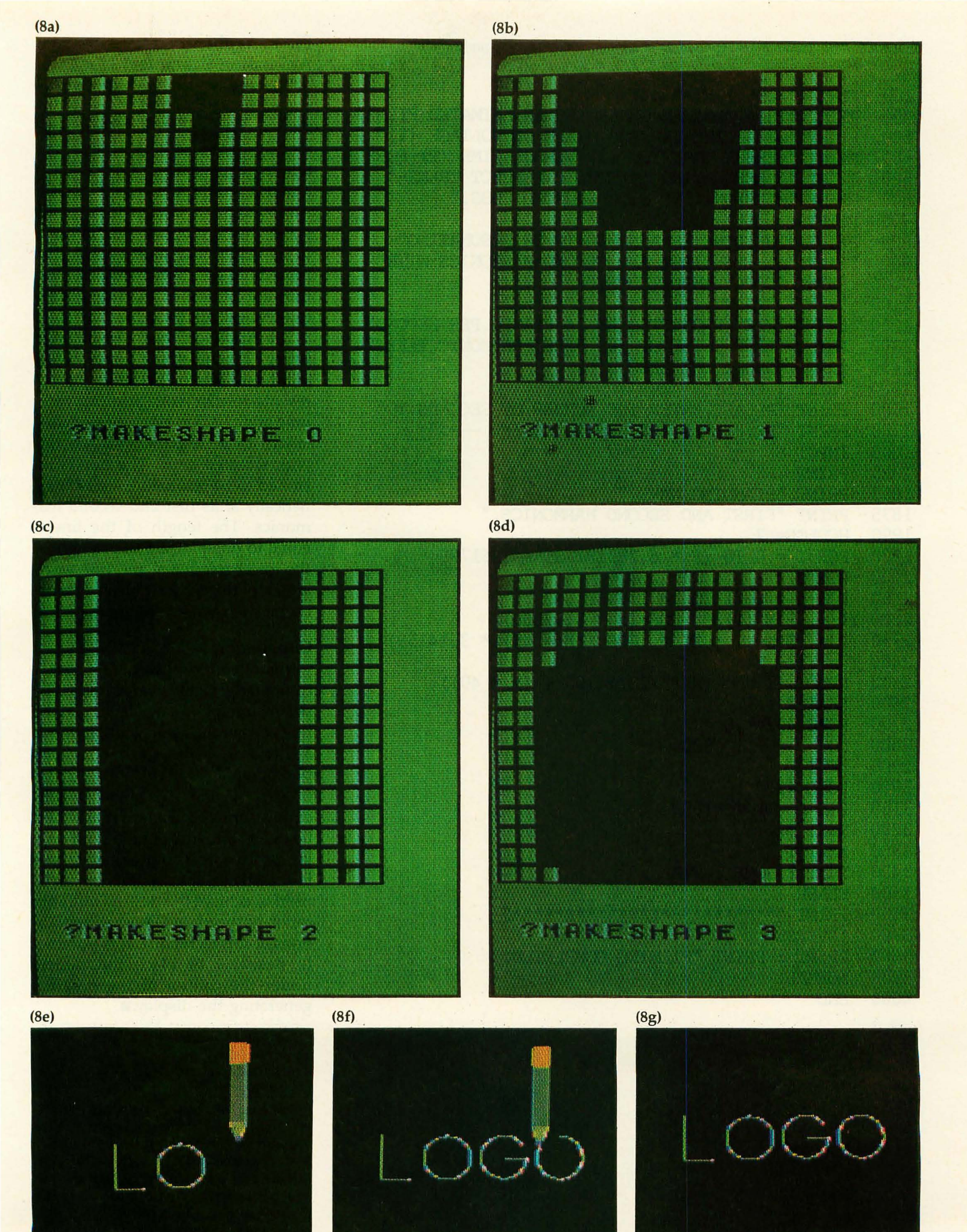
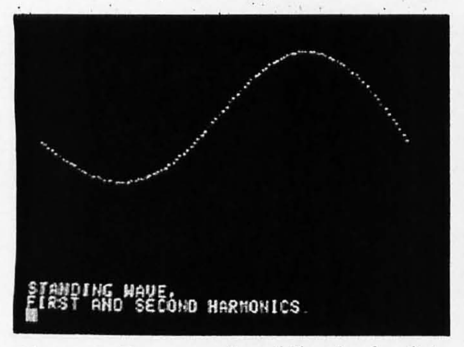


Photo 8: *TI Logo shape definitions (photos 8a through 8d) and the resulting action shots (photos 8e through 8g).*

Listing 2: *An Applesoft listing used to generate a time-varying graph.*

```
100  TEXT : HOME : VTAB 5
200  PRINT "THIS PROGRAM GENERATES AN ANIMATED FILM"
300  PRINT "OF A TIME-VARYING GRAPH OF VOLTAGE (Y)"
400  PRINT "VERSUS POSITION (X) VERSUS TIME (T) FOR"
500  PRINT "A RESONATING LENGTH OF PERFECT TRANS-"
600  PRINT "MISSION LINE WITH SHUNTED ENDS."
700  PRINT
800  PRINT "THE LINE IS ASSUMED TO BE RESONATING"
900  PRINT "AT ITS FIRST AND SECOND HARMONICS WITH"
1000  PRINT "EQUAL AMPLITUDES."
1100  PRINT
1200  PRINT "WHEN PROJECTED AT 24 FRAMES PER SECOND"
1300  PRINT "EACH CYCLE OF THE FIRST HARMONIC TAKES"
1400  PRINT "ABOUT ONE SECOND."
1500  PRINT : PRINT
1600  PRINT "PLEASE ENTER THE NUMBER OF SECONDS TO"
1700  PRINT "BE FILMED. RETURN TO BEGIN. --->";
1800  INPUT S
1825  PRINT
1850  PRINT "STANDING WAVE,"
1875  PRINT "FIRST AND SECOND HARMONICS."
1890  HCOLOR= 7
1900  FOR T = 0 TO (S * 6.28318) STEP .261799
2000  HGR
2100  FOR X =  - 1 TO  + 1 STEP .02
2200 Y1 =  SIN (T) *  COS (X * 1.57080)
2300 Y2 =  SIN (T * 2) *  COS ((X + .5) * 3.14159)
2400 Y = Y1 + Y2
2500  HPLOT (130 + (X * 120)),(90 + (Y * 40))
2600  NEXT X
2700  POKE 49241,0
2800  FOR D = 1 TO 300
2900  NEXT D
3000  POKE 49240,0
3100  FOR D = 1 TO 1000
3200  NEXT D
3300  NEXT T
3400  TEXT : HOME : VTAB 10
3500  FLASH
3600  PRINT "*************************"
3700  INVERSE
3800  PRINT : PRINT "FILMING COMPLETED."
3900  NORMAL
4000  END
```



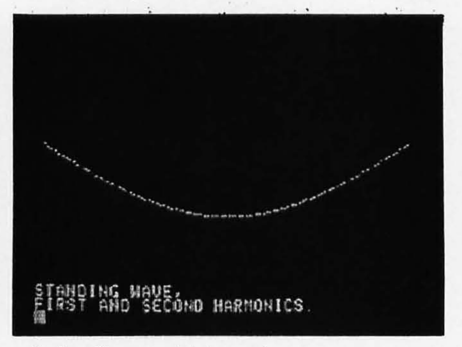


Photo 9: *Two examples of the Applesoft transmission-line model in action.*

Photographic Animation Examples

The set of TI Logo procedures shown in listing 1 and shape definitions shown in photo 8 cause the previously described TI hardware system to generate an animated film of a pencil writing the word "LOGO." Although this animation looks pretty good on the monitor, the film provides better animation quality. The procedures are given in the order that they are first called. ACTION is the top-level, script procedure.

The Applesoft program shown in listing 2 generates a time-varying graph (see photo 9). The graph represents relative voltage in terms of time and position along a resonating length of perfect transmission line with shunted ends. The line is assumed to be resonating electromagnetically at its first and second harmonics. The length of the line is equal to one-half the wavelength of the lower frequency and one wavelength of the higher. The amplitudes of the two frequencies are the same.

Conclusion

It is often useful to photograph a computer-generated video image. Exposure timing, ambient light, and the positions of the camera and monitor are critical to the success of such photography.

When a computer is able to generate a series of displays that would be interesting or useful if—and only if—display rates could be many times faster, photographic animation can be used to achieve the desired multiplication of speed. In almost all applications of this technique, it is extremely desirable to place the camera under the control of the program generating the display.■

This project was carried out under the auspices of Logo Computer Systems Inc. (9960 Cote de Liesse, Lachine, Quebec H8T 1A1, Canada, (514) 631-7081).

Peter Cann, who is almost entirely self-educated in the computer field, has a near congenital fascination with machines. His first exposure was to an IBM 370 running FORTRAN. After a brief stay at MIT and a few years of freight handling, he wound up at Logo Computer Systems. He is now with Atari (5 Cambridge Ctr., Cambridge, MA 02142) maintaining a Unix VAX. Peter enjoys hacking anything that beeps, whirrs, or crunches.

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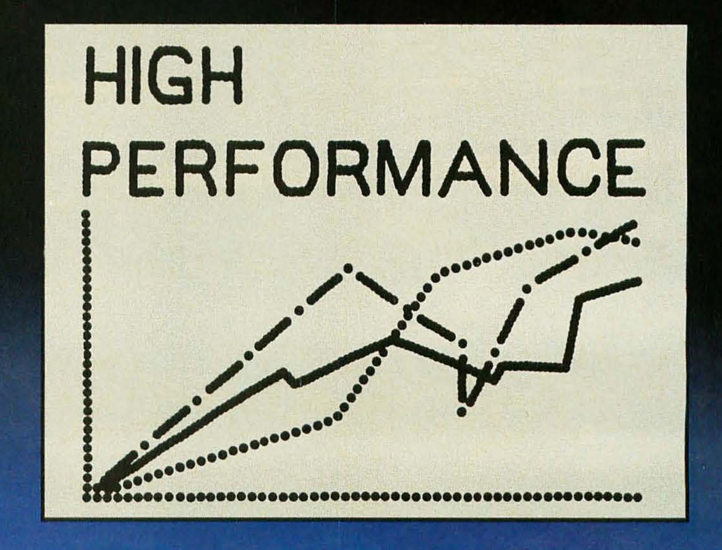
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The Fourth National Computer Graphics Association Conference

Graphics hardware is better, faster, and cheaper—but the software still lags behind

by Alexander Pournelle



Photo 1: *A view of McCormick Place, where NCGA 1983 was held. (Photo by the author.)*

The National Computer Graphics Association (NCGA) Conference is to computer graphics what the National Computer Conference (NCC) is to the entire computer industry. All the manufacturers go to the NCGA show to exhibit their latest in picture-making equipment. The conference is only about a quarter the size of the NCC, but that means there's a fighting chance one person can see the whole show. (Some of the companies represented at NCGA and SIGGRAPH are listed in the text box at the end of this article.)

This summer's NCGA was held in Chicago's McCormick Place, the largest convention hall in the United States (see photo 1). I spent only two days at the show last year. I was at this year's for four solid days and still didn't see every booth and exhibit.

What can these newfangled machines do that Aunt Rhoda's Atari can't? Well, an Atari 800 can display only eight colors at a time on a field of 320 by 192 pixels (picture elements). The very best in computer graphics displays are 4096 by 4096 pixels and can display over 16 million colors. Top-of-the-line machinery can write at more than 10 million pixels per second, making images move incredibly fast. Only the most demanding applications can currently justify the high price ($30,000 and up) that quality demands. Prices are falling, however. What was $100,000 last year is now $50,000.

The theme of 1982's NCGA conference was electronic drafting. This year, the focus moved to electronic graphs. Businessmen surpass engineers as the largest market segment. Businesses want "presentation graphics"—bar and line graphs, pie charts—and they're willing to pay a lot for them. The tone of this year's NCGA show was quite different from last year's. Electronic drafting and CAD/CAM (computer-aided design/computer-aided manufacture), although still very important, were second-place topics behind presentation graphics. Office automation (which overlaps the graphics industry) and imaging tied for third place. New companies making one or two graphics devices were the most exciting part of the show, as always.

Robert Heinlein fans will be happy to know that Drafting Dan, from the book *Door into Summer*, is alive and well. Heinlein described Dan as a cross between a drafting table and a typewriter but didn't predict that plans would be laid out on a video display before pen ever touched paper. Tedious redrawing for engineering change orders can be all but eliminated with current CAD/CAM equipment.

Why are so many people interested in business graphics? It seems that designing a building is less important than presenting last year's sales figures in color. Management wants more productivity; color graphs can be drawn by computer much more quickly than by hand. The data is available before it's out of date. "Graphics at Work" was the show's official theme, but "Improving Business Communications" would be more accurate.

Drawing software at the conference ranged from poor to good.

What are people in business doing with computer graphics? They're doing lines, bars, and pies: the three basic chart groups. I thought it was tragic to see so much equipment making such unimaginative pictures. I can only hope this will change. (For the author's report on a show emphasizing more imaginative graphics, see the text box at the end of this article.)

Last year I complained about the lack of games at the conference; it's a shame because games can demonstrate just what all this incredible machinery can do. This year I figured out why there are no games: credibility. The attitude I encountered was, "Can you imagine some corporate vice-president walking up to my booth and seeing Star Raiders? He'd never buy anything from me!"

Show Highlights and Lowlights

Interest in graphics is accelerating—the NCGA show grew about 20 percent in floor space this year; already the number of companies signed up for 1984's show exceeds the number of this year's exhibitors. The highlight of 1983's show was galloping technology that's resulting in some outstanding equipment with astonishing potential. The show's lowlight was the drawing software, which translates the operator's (or artist's) commands into pictures. Drawing software at the conference ranged from poor to good; none of it was excellent.

The drawing software currently available enables you to draw lines, boxes, shades, circles, planes, and so on, but it lags behind the hardware by two years or so. Like most microcomputer software, it's not very self-explanatory or helpful. Slowly, microcomputer software has improved; there's a bunch that is really outstanding. I see that trend in drawing programs. A major cause of the lag is that companies formed to make new graphics products usually make hardware. If they write any software, it is often to test their new boards. As a result, the new guys on the block (and there are a lot of them) have incredibly powerful hardware but nothing to do with it. When the IBM Personal Computer was announced, little software was available. The situation improved when software writers saw the enormous potential market. The graphics market is perhaps less concentrated but almost as large as the PC software market.

New Product Profiles

Shows are horrible places to get any in-depth data on new products; nothing works perfectly. One company's main processor died the first afternoon of NCGA and wasn't revived until the next day. On the other hand, shows are great if you're worried about a company's product reliability. Electronics are notorious for breaking when moved.

Prices are plummeting. New, low-priced, medium-performance, medium-density boards were everywhere this year. Of course, low price to people in the graphics industry means $4000 and up because they're used to paying $40,000.

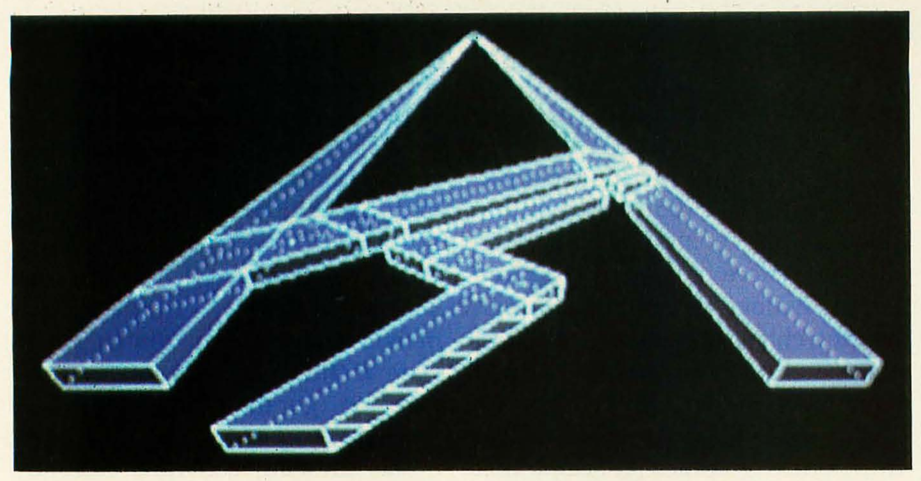


Photo 2: *Color graphics from the Rampage board by Parallax Systems. The Rampage currently runs on LSI-11 machines, including the Heath H-11. (Photo by the author.)*

A new product of interest is the Rampage, a low-priced, high-performance, medium-density board. The manufacturer, Parallax Systems Inc., started (of course) in a garage. Seven ex-employees of other graphics companies thought they could do better than their old bosses.

They may have been right. The Rampage awed other design engineers at the show. They would come over to the Parallax booth, quietly watch some demonstrations, then return later with more designers. What was so impressive was not the actual pictures being displayed but the speed with which they could be manipulated. Photo 2 shows the Parallax company logo in transparency; note how the lines behind it are dashed. The Rampage can switch quickly between this translucent mode and hidden-line mode (in which none of the back side shows). The board (about $7000) is priced at less than a quarter of the nearest competition. Currently, the Rampage works only on the Digital Equipment Corp. (DEC) Q-bus, although Parallax plans to make different versions available quickly.

3M (you know, the makers of Scotch Tape) announced an interesting item: a fast overhead-transparency maker. Expect it at your graphics service bureau late this year or early next.

CP/M has long lacked any kind of graphics standard. Digital Research Inc. (DR) formulated what it calls GSX, or Graphics System Extension, but almost no companies use it. The Visual 1050, a CP/M-based machine (see photo 3) that has true monochrome dot graphics (640 by 300) built in at no extra cost, debuted at NCGA. The 1050 uses DR's GSX, can emulate a DEC VT-100, and comes with Wordstar, Multiplan, CBASIC, and CP/M 3.0; it should be available by the time you read this.

Speaking of CP/M, DR had better watch out for Unix. I was surprised last year to see so many CP/M-compatible machines but was more surprised this year to see a great switchover to Unix and Unix-like operating systems. Graphics depend partially on operating systems for portability, and CP/M is still not set up properly for graphics.

As IBM PC look-alikes proliferate in the micro world, so do DEC VT-100 and Tektronix Inc. 4014 look-alikes in the graphics world. There are many

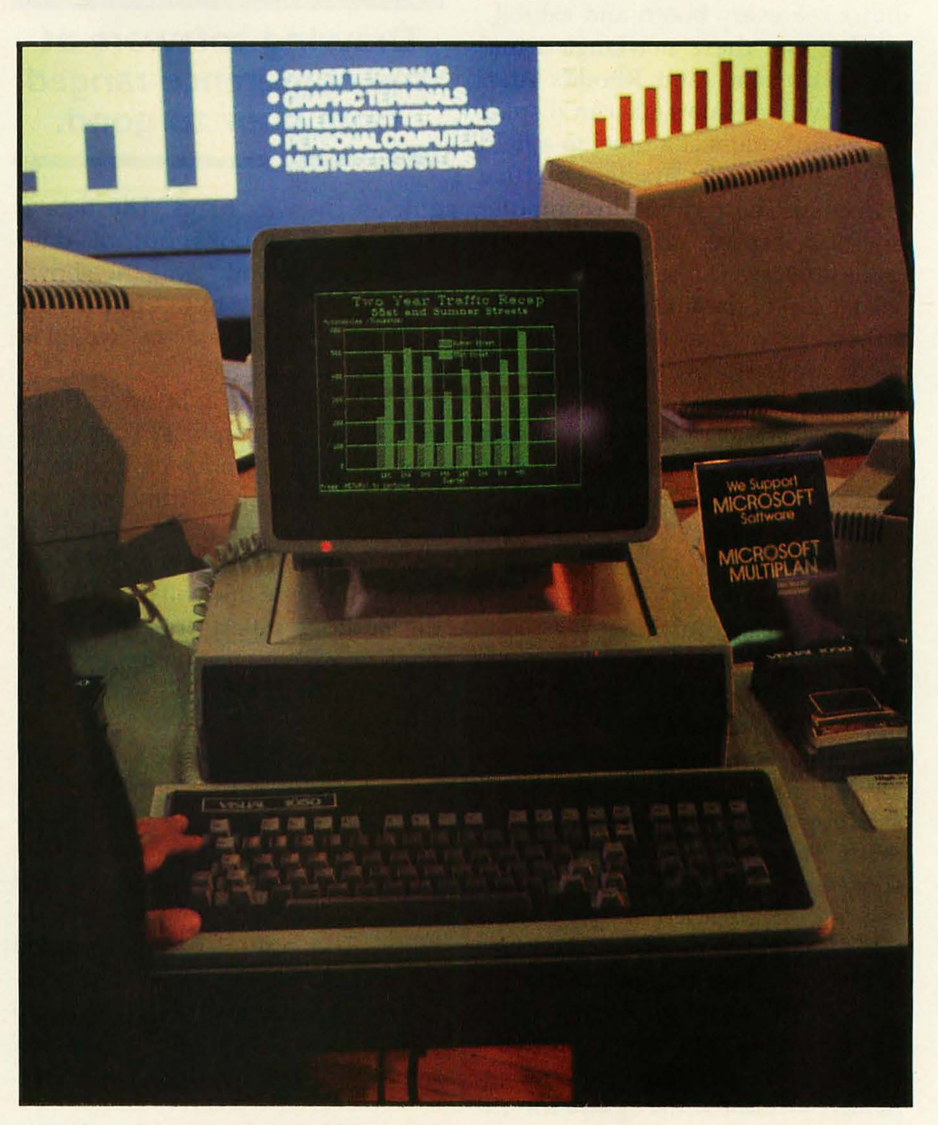


Photo 3: *Visual Technology's first move from terminals to computers. This version of the 1050, with software, two drives, CP/M 3.0, and manuals, lists for $2695. True dot graphics are displayed with text. (Photo by the author.)*

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The Changing Face of Computer Graphics

Computer graphics systems are usually composed of the same basic parts. First, there's the operator, without whom not much gets done. Next is the main processor or host computer, which does the thinking. Then there's the display computer, which holds and may process the image being displayed. These pictures or images are displayed on a video monitor, which is much like the guts of your television set. The software controls everything.

Getting data into the computer requires input devices such as mice, bit pads, trackballs, keyboards, and video cameras. For more permanent image copies, there are output devices like plotters, printers, and slide cameras. Communications links, usually cables, connect all these parts. A typical computer graphics system is shown in the photo below.

The division between these parts is somewhat arbitrary; the host computer, for instance, may be part of the graphics system. There may be only one processor hosting and displaying (as in Apple Computer Inc.'s Lisa). However the parts fall together, the sum is only as fast as its weakest link. That weak link is often the controlling software.

Standards

The difficulty of moving software from one machine to another is directly proportional to the differences between the two machines. That's why the whole graphics industry has decided on some de facto standards and one formalized one. The formalized standard is the ACM/SIGGRAPH CORE standard. Unfortunately, it came along too late for universal acceptance. Many machines conform to it, but older, less ambitious standards—namely PLOT10 and FORTRAN—are still prevalent.

PLOT10 was designed by Tektronix more than 10 years ago so that FORTRAN programs could draw pictures on the then-new Tektronix graphics terminals. One Tektronix employee admitted no one ever expected PLOT10 to survive longer than five years. But like color television and the QWERTY keyboard, any standard will survive if enough units are in the field. The same reasoning applies to FORTRAN, which has become self-perpetuating. Every new machine must have a FORTRAN compiler: no one wants to rewrite that giant catalog of old programs. If this isn't depressing enough, one of the products at the NCGA show was a processor that ran FORTRAN directly in microcode.

Graphics systems come in two types: raster and vector. A television is a raster device—pictures are drawn from left to right across the screen, a line at a time. In vector graphics, the lines in a picture are drawn contiguously; to draw a square, vector graphics draws all four sides, one at a time. (See Gregg Williams' article "A Graphics Primer," November 1982 BYTE, page 448 for more information.) Vector graphics machines are slowly losing their position; even CAD/CAM systems, the largest users of vector graphics, are switching to raster. Vector may never die out completely, but raster will be what the majority use.



A complete graphics system that includes an Apple IIe (background left) and a Jupiter 7 (foreground right). Commands are entered with a Summagraphics bit-pad pointer.

Two Strategies for Generating Images

Generating computer pictures requires much data manipulation. One photo represents millions of operations by the computer. These operations can be performed either directly by special-purpose hardware or by special-purpose software running on a general-purpose computer.

Among those who generate video and film computer graphics are followers of both camps. Lucasfilm, the company that brought you the *Return of the Jedi* graphics, uses a lot of specialized hardware. Digital Productions owns a Cray-1, a very fast general-purpose mainframe, and doesn't use much specialized hardware. Both approaches have their pluses and minuses. Hardware takes longer to realize but can manipulate very quickly. Developing software that generates images takes less time than developing hardware, but the finished software isn't as fast as special-purpose hardware. A combination of new hardware and software is much more difficult to coordinate; at least some items should be "stock" or familiar.

Communications

Computers usually talk to terminals and modems in "serial" fashion: one bit at a time. The most popular method of communicating, the RS-232C port, is susceptible to noise, can work only over short distances (25 feet), and is comparatively slow (only up to about 1000 characters per second). Two much more modern methods of communicating serially are the RS-422A and RS-423A ports, but the industry, largely due to inertia, has not yet changed to these standards. It's unfortunate because these newer communications standards solve the problems of the RS-232C and run very fast. Speed is important

because most display and host computers can run much faster than the line between them, which means screen updates (displaying new pictures) take longer than they ought to. I know of no computer company (graphics or otherwise) that uses RS-422A or RS-423A ports to move data. In the graphics field, I had hoped to see optional RS-422A on some terminals and computers, but it didn't happen this year. Sooner or later, at least one company will offer RS-422A *and* RS-232C ports, and the ball will roll. A really fast terminal is especially important in graphics because a nice picture can be as long as 25,000 words.

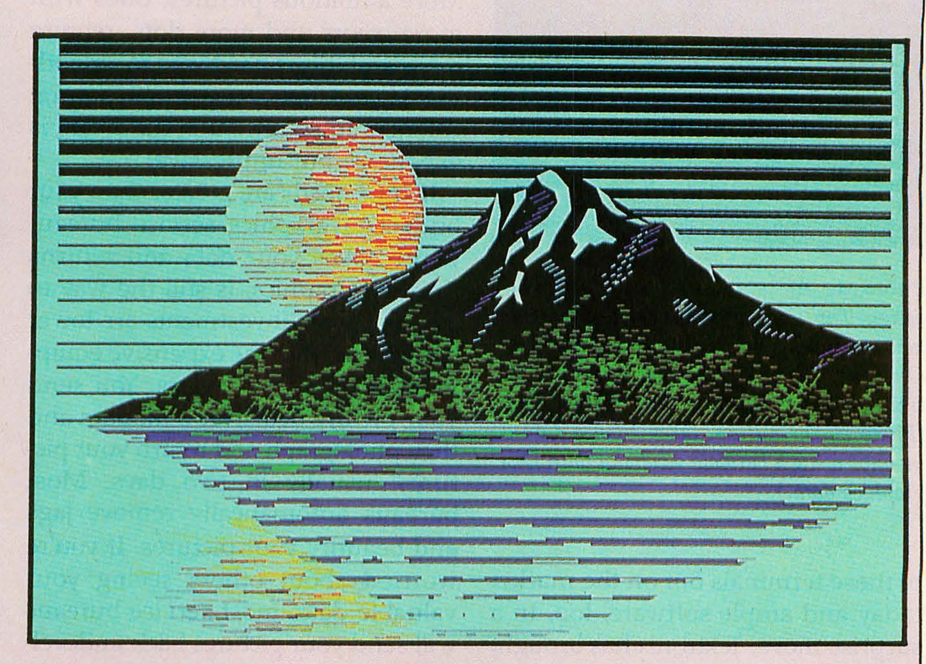
Portrait of the Computer as a Young Artist

I'm not a very good draftsman or artist. With a computer, I can draw straight lines; more important, I can erase. Artists and nonartists alike can benefit from computerized graphics systems. Nonartists benefit because another means of communication opens for them; artists benefit because the drudgery, the repetitive work is lessened. If the world wants "boilerplate" pies, bars, and lines, it can have them quickly and professionally.

Computers are great for the commercial arts, but what about the fine arts? The photo at right shows an image that could qualify as an example of either commercial or fine art. At SIGGRAPH, there is an art show just for computer graphics art.

I don't think artists will be replaced by computers. Instead, the drudge work will be automated, leaving more time for creative work. A computer can be an artist's tool, just as premade brushes are a tool. Soon, an artist will be able to walk into an art supply store and buy a new reflections package as he would a tube of gouache. This will be a sort of industrial revolution for art.

There is, however, one major controversy. When is art actually original? If I have the tools, it doesn't take long to set up the machine to make a really beautiful drawing. But I didn't do the work of painting the reflections—the computer did, with software someone else may have written. The problem will fade in importance as the public becomes more familiar with computer pictures and more demanding about what it sees. The problem of judging originality should lessen as graphics acquire a history.



Is it commercial art or fine art? Eleanor Matthews used the Beacon Illustrator system by Florida Computer Graphics to produce this picture. The Beacon has a point resolution of 640 by 480, but the picture's resolution was increased to 2000 by 2000 with Matrix Corp.'s Lasergraphics enhancer unit. The image was then photographed with a Matrix QCR.

What It's All Good For

Education: Schools and computer graphics will go well together. Consider how much easier teaching economics would be if graphs of demand curves and gross national product could be changed instantly. If students could access and experiment with the data, "math phobia" could be conquered.

Such developments await lower prices, better software, and teacher acceptance. The first two are inevitable. An Apple or IBM PC would suffice in the classroom, although not as well as a larger machine. With the coming precipitous drops in prices, such tools could be in common use in less than five years.

Office: Computers are slowly being accepted in the workplace. Computer graphics lag behind office automation in businesses. Word processing is still used only by word-processing specialists, not by managers.

But many people entering the workforce now have grown up with computers and aren't afraid to type. They will help their coworkers learn to use computers. Almost every office in middle management will have its own terminal in five years, if only because interoffice mail and electronic memos are so much easier than the paper equivalents. The trend of acceptance will slowly come to include graphics, too. After a while, almost everyone will latch on to the simple graphics triumvirate, bar/line/pie, although artists will still be called to make the more complicated drawings.

Engineering Productivity

Because there aren't enough engineers, we have to make the ones we have work faster. Blueprint changes no longer need be a slow and tedious process. The next barrier is that every engineer will want to have a terminal on his desk rather than wait in line for one of a few terminals. When prices come down, terminals will proliferate very quickly just as soon as management realizes how much more can be accomplished. Several companies, notably Apollo and Versatec, are pushing such combined office/engineering networks.

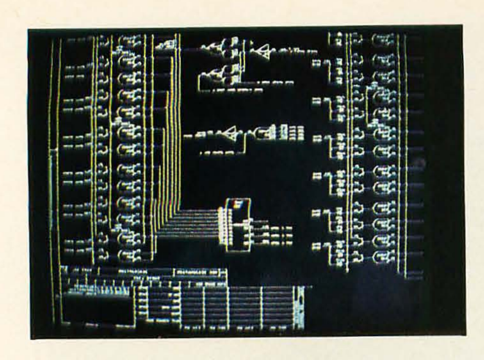


Photo 4: *An example of computer-aided design. This DEC schematic demonstrates just how much detail the best equipment can show. On the original screen, you could see the tiniest writing in the bottom right corner. (Photo by the author, taken from a Conrac monitor using a Lexidata generator with DEC graphics data.)*

of these terminals out on the market today and ample software, too. In a surprise move, Tektronix has brought out a relatively low-cost line of terminals that emulate both a VT-100 and Tektronix's own 4014 with color. At $4000 to $8000, the 4100 family is going to be very popular.

Last year I said that Conrac (a longtime maker of video monitors) didn't want to be overrun by the Japanese and was quickening its usually sedentary pace of product introduction. It displayed several new products, including what I thought was the best monitor at the show. It was a 19-inch 60-Hz noninterlaced model that was great to watch. Photo 4 shows an image from that monitor; I warn you that it looks better in person.

If picture quality is of major importance to you, a dedicated camera is in order. Polaroid Corp. has now entered the graphics camera market with low- to medium-priced ($2000 to $7500) camera packages that attach to IBM PCs or Apples and make transparencies, prints, or slides. The Videoprinter line was making impressive screen copies from an IBM PC. Lang Systems Inc., maker of the Videoslide recorder, was worried about such large competition, but its unit is more adaptable than Polaroid's. The market should support both. These cameras don't do much more than take a picture from a screen. That means the picture's resolution—how many dots high and wide—is the same as your screen's. More ambitious pictures, ones with more colors and more dots, require more ambitious hardware to smooth out jagged lines, use more natural colors, and so on. Such hardware is expensive but impressive.

If your needs are greater than your budget, a graphics service bureau, which takes your data and returns finished graphics, is still the way to go. Hardware investments are lower because most of the expensive equipment is theirs, not yours. You send your picture data over a modem and they photograph and return your pictures, usually in two days. Most bureaus automatically remove jags and beautify your pictures. If you're worried about others seeing your valuable data, most service bureaus will send your pictures back undeveloped. Bureaus charge between $5 and $15 a slide (less for large orders).

True 3-D was before its time and remains a pretty sideshow. Obviously, true three-dimensional display (as compared to three-dimensional projection on a two-dimensional picture tube) is a powerful tool, but it's yet to be perfected or accepted. I hope I'm at the show when holographic computer graphics are first demonstrated; it will be an exciting milestone.

The prize for best give-away item goes to Jupiter Systems for its "Show Hospitality Sweet," a chocolate shaped like the planet Jupiter, complete with red spot. Jupiter also showed off its new Jupiter 12, a computer graphics workstation with higher resolution than the Jupiter 7.

The Works, scheduled to be the first all-computer-graphics, full-length motion picture, is still stalled without enough capital. The world will wait another year.

Commercial graphics houses are producing. Digital Productions is handling the space footage for *The Last Starfighter,* to be released next year. The company is rumored to be working on good computer models of the human figure, too. I wish I could show you some pictures, but Digital Productions is understandably secretive.

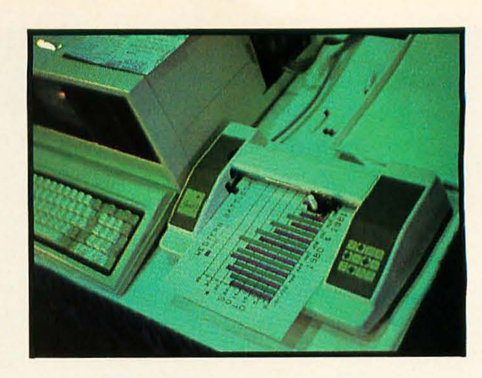


Photo 5: *The Enter Computer Sweet-P plotter fits into a briefcase and is relatively light. The pen moves in one direction only; the paper moves in the opposite direction. Enter has made plots "up to 10 feet long" on the Sweet-P using this feature. (Photo by the author.)*

Networks and Graphics

Versatec's network, called the Expert, is based on the ill-marketed Xerox Star and combines office automation and CAD. Versatec (a division of Xerox) is more famous for a laser printer/plotter that intersperses pictures and text. The unit does a professional job, and I've noticed only one problem: the text doesn't look as good as phototypeset text, which I'm told is a function of how many dots per inch are laid down. The new generation of laser printers should be an improvement.

Apollo Computer Inc.'s Domain network is meant more for office automation than design, although it does both. It has some very important network features. You can access data from other nodes (terminals) as easily as from your own, which means you can get a program from your coworker's disk and run it or send files to any printer on the network. The network has some ambitious security provisions. One important security item: each terminal has a floppy disk, so you can take your data with you. Why don't the micro companies sell a network like this?

At the moment, the cost of such networks prohibits giving every user a terminal, but don't be surprised if this changes in two years.

Some Product Developments

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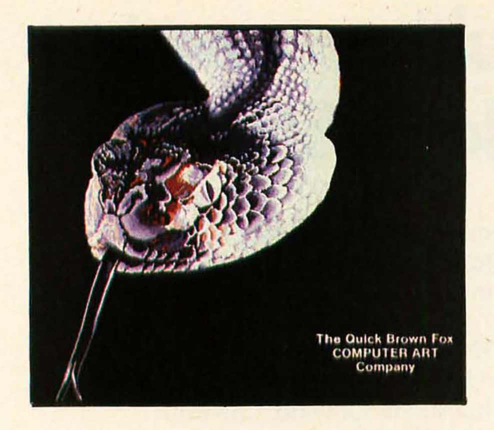


Photo 6: *This image was drawn by hand. The artist used a Summagraphics bit pad and software designed for drawing by hand. The system, put together by New England Technology, uses a Jupiter 7 and an Apple IIe. (Photo by Quick Brown Fox.)*

Computer Corp. has a cute little plotter it calls the Sweet-P (see photo 5). Unlike the more advanced plotters, the Sweet-P is easily interfaced to most common micros over a Centronics or RS-232C line. Enter showed the Sweet-P working on a Compaq and a Kaypro II. Plot commands can be sent in an MBASIC LPRINT statement, meaning you don't need very sophisticated software to make some rather impressive graphs. Plot pens are changed by hand. Epson America Inc., the world's largest volume-manufacturer of printers, has selected the $795 Sweet-P as the companion to its QX-10 computer.

Eagle Computers makes more than computers: Eagle started as Audio Visual Laboratories and then branched into computers. This explains the keyboard on its IBM PC work-alikes; it has keys marked with visual terms such as "enhance." Now there is a combination product: "A complete desktop computer graphics system" that includes a digitizing pad, an 8086-based computer, a high-resolution monitor, and a camera.

Ithaca Intersystems, an S-100 computer company, brought out the Graphos VT-100-compatible color graphics terminal. The Graphos has a screen resolution of 640 by 480 pixels; it supports up to 16 windows or independent screens within the screen. Each of these windows can display 16 different colors. Graphos starts at $8000 (a lot less than most of its competition) and can be expanded to include an S-100 card cage. I asked the Ithaca people why a nice S-100 company is going into graphics, and they said they didn't want to stay a nice little S-100 company. Bravo.

Computer graphics can be created two ways: from scratch (by hand, as in photo 6) or from real-world data (photos, maps, diagrams, or any television image). The second method is called imaging, a very powerful tool. Imaging is used in medicine to "clean up" x-rays and CAT scans. Space and astronomical photographs are enhanced on similar equipment. Gould Inc.'s DeAnza Imaging and Graphics division had what I thought was the best imaging equipment at the show. DeAnza was showing images good enough to eat (see photo 7).

Color Picture Tubes

Color "bottles" are all foreign-made, mostly in Japan. The American firms have given up without a fight. American graphics companies would love to use domestic tube; it's often the only foreign-built part in their machines. But unless some more elegant display method comes along, the foreign monopoly is likely to continue.

There's still no replacement for the television picture tube. IBM announced a step toward it at NCC: a dense plasma display (July 1983 BYTE, page 297) which it had working on a PC. The display doesn't offer color and it isn't cheap, but the only vacuum tube most of us use is closer to being replaced. I won't be sorry to



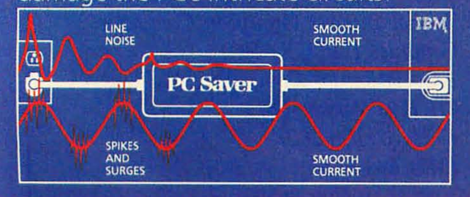
Photo 7: *Tasty imaging. This picture was first taken with a high-quality television camera, digitized, then stored on disk; what you see here was shot from a monitor. Such images can be called up at any time and manipulated; you could zoom in, enhance one section of the picture, save that result, then return to the original. (Photo by the author.)*

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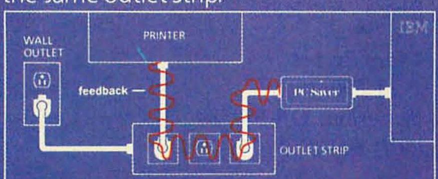
The reality is that power from your wall outlet is far from pure. There is AC line noise—Radio Frequency Interference or RFI—which is the cause of snow on your TV screen when an appliance is switched on. Line noise is interpreted by your PC as data. The results? Errors. Crashed programs. Memory losses.

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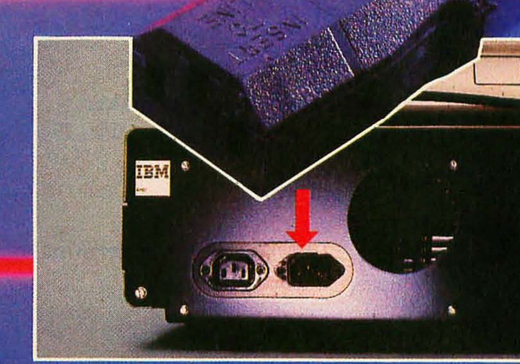
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see it go. By decade's end, all-in-one computers and terminals will optionally come with something other than a picture tube. The tube will never die out; it's like black-and-white film—too familiar and too capable to become obsolete. But the competition will have advantages: smaller computers, lower power consumption, fewer parts to align. The new displays will represent the single largest change in computer components since magnetic cores were replaced by memory chips.

Competition

The Japanese aren't here yet. They displayed a few interesting things at the conference but remain in the wings. Most companies are running scared of their competitors, foreign and domestic; consequently, development proceeds at a fast pace. No one wants to be blind-sided, especially in an industry in which being hit unawares means waiting until the entire crowd passes over you. Because

For More Information

Slide makers and graphics photographic recorders:
Lang Systems Inc.
1392 Borregas Ave.
Sunnyvale, CA 94086
(408) 734-3332

Polaroid Corp.
575 Technology Sq.
Cambridge, MA 02139
(617) 577-2000

Sweet-P plotter:
Enter Computer Inc.
6867 Nancy Ridge Dr., Suite D
San Diego, CA 92121
(619) 450-0601

Fiber optics communications:
Artel Communications Corp.
POB 100, West Side Station
Worcester, MA 01602
(617) 752-5690

Video monitors:
Amtron Corp.
5620 Freedom Blvd.
Aptos, CA 95003
(408) 688-4445

Overhead (Vue-Graph) maker:
3M Audio Visual Division, AV82-19
POB 33600
Saint Paul, MN 55133

Jupiter series of graphics terminals:
Jupiter Systems
2126 Sixth St.
Berkeley, CA 94710
(415) 644-1024

Office automation networks with graphics:
Versatec, a division of Xerox
2710 Walsh Ave.
Santa Clara, CA 95051
(408) 988-2800

Apollo Computer Inc.
15 Elizabeth Dr.
Chelmsford, MA 01824
(617) 256-6600

Image-processing systems:
Gould Inc., DeAnza Imaging and Graphics Division
1870 Lundy Ave.
San Jose, CA 95131
(408) 263-7155

Visual 1050 personal CP/M computer with graphics:
Visual Technology Inc.
540 Main St.
Tewksbury, MA 01876
(617) 851-5000

Rampage fast graphics add-on board:
Parallax Systems Inc.
1030 East Duane Ave., Suite H
Sunnyvale, CA 94086
(408) 720-1600

Color VT-100-compatible graphics terminals:
Ithaca Intersystems Inc.
200 East Buffalo, Box 91
Ithaca, NY 14851

Tektronix Inc.
POB 500
Beaverton, OR 97077
(501) 644-0161

Graphics presentation makers (software and hardware):
New England Technology Group
400 West Cummings Park
Woburn, MA 01801
(617) 938-8833

Audio Visual Laboratories/Eagle
500 Hillside Ave.
Atlantic Highlands, NJ 07716-2197
(201) 291-4400

Antics animation software:
Grove Park Studio Animations Ltd.
104 Grove Park
Camberwell, London SE5 8LE
England

AC gas discharge plasma display:
Photonics Technology
POB 432
Luckey, OH 43443

Apple/IBM color graphics add-ons:
Number Nine Computer Engineering Inc.
POB 1802
Hartford, CT 06144
(203) 233-8134

Software for Number Nine board:
Visual Data Enterprises
POB 30563
Los Angeles, CA 90030
(213) 250-4977

Apple/IBM-based postproduction graphics equipment:
Symtec Inc.
15933 West Eight Mile Rd.
Detroit, MI 48235
(313) 272-2950

Beacon Illustrator system:
Florida Computer Graphics
1000 Sandy Pond Rd.
Lake Mary, FL 32746
(305) 321-3000

Graphics shows and associations:
National Computer Graphics Association
8401 Arlington Blvd., Suite 601
Fairfax, VA 22031

Special Interest Group on Computer Graphics (SIGGRAPH)
Association for Computing Machinery
111 East Wacker Dr.
Chicago, IL 60601
(312) 644-6610

neither hardware nor software can do much alone, the single technological "gotcha" is not as large a worry as the company that quietly goes for two years without a major product change and then announces a whole line of new machines. No one did that at this year's show, but I wonder if it won't happen in 1984.

People frequently start graphics companies to compete with their former employers, often with direct product copies. Watch for a shakeout, with some "me-too" companies merging. One-product companies that don't branch out may find themselves in serious trouble. Will the market support four firms making exactly the same CAD/CAM equipment?

For all of you who have read Tracy Kidder's *The Soul of a New Machine*, this won't come as a surprise. Data General (DG) announced the MV/10000, a more powerful MV/8000 (the machine described in Kidder's book). The MV/8000 is a direct competitor of DEC's VAX 11/780 computer, but the MV/1000 has no real competition (from DEC, anyway). One prominent DEC employee was overheard saying DEC won't have anything for at least a year and a half to compete with the MV/10000. This is a perfect example of how a single product can stomp the competition. DEC will lose customers to DG the way DG lost customers to DEC, then DEC might come out with an ultra-VAX that takes customers from the MV/10000.

Computer graphics require large amounts of data very quickly; most large color terminals have enormous cable bundles connecting them to their host. Fiber optic cables transmit over a much more modest light-conducting fiber, which Artel Corp. demonstrated by sending data from booth to booth over very thin cables. The image received wasn't quite as good as one transmitted by coaxial cable, but fiber optic lines really come into their own after about 50 feet. At longer distances, coaxial cables are susceptible to screen interference; fiber optic cables are not.

What Next?

Within five years, I think a lot of small businesses from interior decorators to tailors will make use of graphics. Home animators, architects, and (of course) game designers already use graphics; watch for magazines like *Computer Animator*. Rock bands are already using graphics. Anyone who wants fast previews of reality without waiting for a draftsman will appreciate CAD/CAM-type systems. We can expect graphics consulting houses to spring up the same way software companies have. High-density, low-cost computer graphics are as powerful a wave as the microcomputer revolution itself.■

Alex Pournelle is chief programmer at Workman Associates (112 Marion Ave., Pasadena, CA 91106). He also attends UC San Diego and is collaborating on a textbook. He would like to hear from people working on low-cost graphics visuals.

The SIGGRAPH Conference

The NCGA show focuses on the business side of graphics; the SIGGRAPH conference focuses on innovation. SIGGRAPHs are run by the Special Interest Group on Graphics, which is part of the Association for Computing Machinery (an organization of computer professionals, students, and academicians). The conference is officially named the "Annual Conference on Computer Graphics and Interactive Techniques," but everyone calls them SIGGRAPHs. This year's, the tenth, was held in Detroit's Cobo Hall in July.

For a novice, SIGGRAPHs are much more engaging than NCGA shows. If you're curious about what Lucasfilm is up to, want to make your own cartoons at home, or want a fast education on graphics, this conference is the place to be; you see the leading edge in computer graphics. Don't misunderstand: the two conferences are different in emphasis, not in quality. At SIGGRAPH, the emphasis is on the new, whether it's better pictures, better machinery, faster computers, or new ways of using graphics.

The art show was worth the trip alone. There were exhibits of "pictures" (wall hangings) and "videos" (moving pictures on videotape), both ranging from fair to superior. Several pieces required less than $15,000 in equipment, which is a modest investment in this field. Encouragingly, much of the work came from schools with computer graphics courses.

In addition to the art exhibit, there was a film and video show. About four hours of computer graphics were shown over two nights. The material ranged from pure art to pure entertainment. Demonstration reels included commercials, network logos, and presentations. Not all of the notable artistic films and videos were computer-generated; some were computer-enhanced or hybrid (analog/digital) material.

"ACT III," six minutes of graphics synchronized to Philip Glass music, was an impressive piece. "Oua Oua," made live by Ed Tannenbaum on his homebrew Apple-based system, was pure fun. The piece that elicited the greatest reaction from the crowd was a short segment (about 45 seconds long) from *The Works*, billed as the "first all-computer-generated, full-length motion picture." This film was started by the New York Institute of Technology's Computer Graphics Laboratory about three years ago, but lack of computing power and money have delayed its completion.

SIGGRAPH also sponsors one- and two-day courses on various topics within the field: computer-aided design (CAD), robotics, solids modeling, animation, and so on. I attended most of the Introduction to Animation course and was very impressed. I learned a lot about computer animation and how much more there is to learn.

More New Products

Because NCGA and SIGGRAPH are

Text box continued on page 380



A frame from an animated film produced by the Nippon Animation Co., Tokyo, using the Antics software.

Text box continued from page 378:
only a month apart, I thought SIGGRAPH would offer little new to see. But that was not the case. Several companies decided to skip NCGA and show off their new products *only* at SIGGRAPH. What follows is a short report on the newest and the best.

For the Apple II or IBM Personal Computer user, there's a new series of high-resolution color boards from Number Nine Computer Engineering (named after the Beatles' song "Revolution Number Nine"). Starting as low as $895, this expandable board has software from Visual Data Enterprises that lets you "paint" and draw on the screen and save images on an Apple disk. Based on the cursory look I got at the system, I'd say Number Nine has a real winner. Most functions (zoom, pan, scroll, plane selection) are under software control. The board comes standard with 16 colors, 512 by 512 resolution, and RGB-TTL interface. It's definitely worth examining if you want to do some home or business graphics.

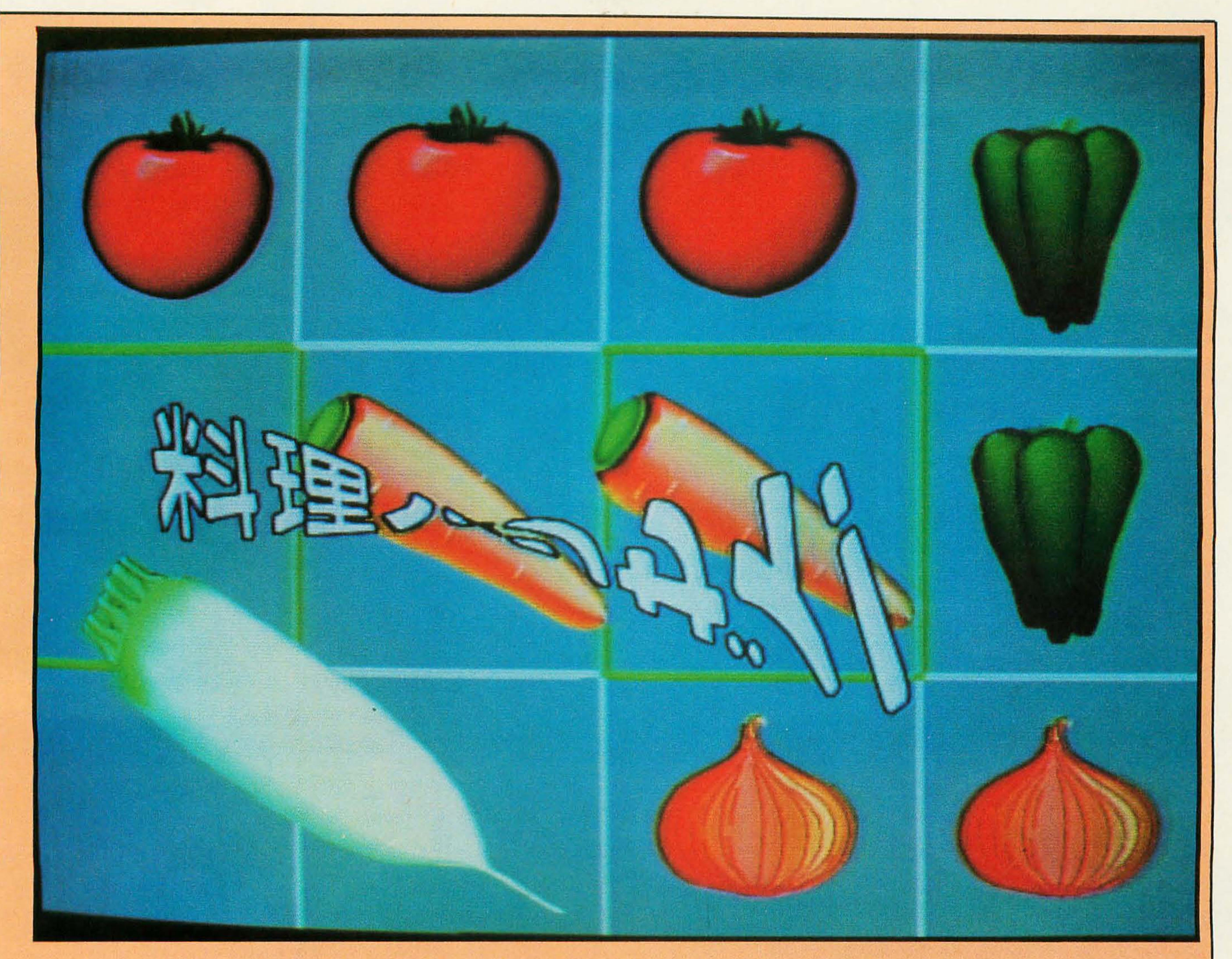
There is a lot of room between Number Nine and companies that make equipment for the television networks. Symtec Inc. announced the PGS III system for the Apple II or IBM PC. Designed to produce graphics for low- to medium-budget video projects, this box is good for postproduction work. It can't compete with network broadcast graphics and isn't meant to. At $2000 (black and white) to $10,000 (deluxe color), the PGS III is much more affordable than the equipment the networks use.

Plasma screens are here and they look great if you want a big, bright, monochrome (one-color) display. Photonics Technology showed its 42- by 42-inch orange plasma display, which is only ½-inch thick. It's very easy to look at in any light; because it's transparent, you can put a drawing behind it for tracing. Although too expensive for the average user, expect to find them commonly used for design conferences in five years. Considering that plasma units are very large (1-meter diagonal measure), they are the most rugged thing available. The army is using them for battlefield situation displays.

IBM also believes in plasma displays. Big Blue exhibited a plasma display, in a terminal, that can show one to four separate tasks simultaneously. The unit is a smaller version of the Photonics display. Only three things are wrong with it: it's $7000, uses EBCDIC, and has an Egyptian keyboard. Well, hieroglyphic. The same people who brought you the most popular keyboard in America (the Selectric layout) now have one even more cryptic than the PC's. There's a little picture of an open lock on the Shift Lock key, and an arrow shaped like a reversed L on the Return key. Pardon my density, but I didn't figure out that the little open lock meant "shift lock." English is more readable than pictograms. Didn't pictograms go out with hieroglyphics?

Graphics Engines

You thought the 8087 was expensive: most graphics involve crunching a whole lot of floating-point (i.e., real) numbers. Most computers aren't very good at this alone and need an add-on box or card to increase their speed. For instance, the chip that does this for the IBM PC (and other 8086/88



This title frame, from a sequence designed by Nippon Animation, illustrates the coloring and shading capabilities of the Antics package.

machines) is the Intel Corp. 8087, currently about $100. Be happy that it's cheap. Real number crunching begins at "only" $50,000 for minis. Of course, those units are incredibly fast; they are required for the sheer numbers of calculations that graphics require.

Cray Research was pushing the Cray-1 and its bigger brothers as graphics engines. Cray was the only company that didn't bring its own machine; the Cray-1 is a little hard to carry around. If the Mercedes is the sign that you've made it in Hollywood, the Cray (starting at $5 million) is the sign that you want to compute some pretty impressive graphics.

More proof that FORTRAN will never die: the Antics animation software package is written in it. This package has been developed by a group in England called Grove Park Studio Animations Ltd. Antics (not related to ANTIC, the graphics chip in Ataris) works with most hardware (so you can upgrade your black boxes) and allows a great variety of creature and object animation. The photos above and at left are examples of Antics graphics. We have seen only the beginning of the revolution; there are concepts and wrinkles not even thought of yet. And yet Grove Park must use a 25-year-old language for portability.

The Japanese embrace computer graphics with professional relish. They will be a force to reckon with. I expect them to use computer graphics to churn out more film animation. Currently, just about all graphics equipment (except the TV tube) is American-made, as is most innovation. But this is changing rapidly. The U.S. still has a lead but isn't accelerating fast enough to stay ahead. I think computer graphics will become a rage in Japan like cartoon animation is now.

One problem with covering these shows is that there's too much to see. By Thursday, the day the exhibits closed, everyone was exhausted. Videos that had made people applaud or laugh on Monday were greeted with silence on Thursday. Such shows cause information overload. Even if only half the exhibitors have something worth looking at, 10 minutes per booth works out to about 14 hours of looking at equipment. Then there's the art show, the film and video show, technical lectures, parties, and classes. Five full days is barely enough time to spend at SIGGRAPH if you're trying to cover everything.



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Echonet

Part 2: The Compiler

How Echonet produces relocatable code from English-like programs

by C. Bradford Barber

Last month, I introduced Echonet with scenarios and a comparison to other programming systems. This month I'll show how Echonet works by examples and a glossary. The first example presents the Echonet concept and the second example describes, in detail, the Echonet compiler.

In brief, programs in Echonet are *entries* and *objects* stored in an Echonet dictionary. Entries consist of an entry *name*, an entry *definition*, and the *relocatable machine code* that causes a computer to perform the entry's task. Entries are defined by instructions that indicate other entries and objects. Objects contain data used by entries.

Echonet describes programs in terms of their design. While programmers using other languages go through a cycle of establishing requirements and specifications, designing, encoding, testing, and maintenance, an Echonet user repeats a shorter cycle of idea, design, and test. The key is the Echonet dictionary, whose many entries offer a broad selection of preprogrammed functions. Each time a new program is designed, the Echonet dictionary is enhanced by that program for the next design cycle.

Programming Languages

Before studying Echonet, let's review how programming systems currently work. A programming system provides a programming language, an editor for writing programs, and an interpreter or compiler. Interpreters (e.g., most BASICs) execute a program one instruction at a time, while compilers (e.g., FORTRAN) translate a program into machine instructions.

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A programming language—whether it is compiled or interpreted—provides a fixed set of statements, operations, and data types. A language's reference manual describes:

- statements that specify actions; for example, the BASIC statement PRINT X prints the value of X
- operations that specify functions of one or more variables; for example, X + Y computes the value of X plus Y
- data types that describe variables; for example, an integer data type may be any whole number between −32768 and +32767

When you write a program, you write a sequence of instructions, comments, and declarations. The following BASIC program prints 0, 1, 2, 3, 4, 5, etc., until you interrupt it:

```
0010 REM PRINT NUMBERS
0020 LET J = 0
0030 PRINT J
0040 LET J = J + 1
0050 GO TO 30
```

Line 10 is a comment. The instruction at line 20 sets a variable, J, to zero. The instruction at line 30 prints the value of J. The instruction at line 40 increments J by adding 1 to the old value. The instruction at line 50 repeats execution starting at line 30.

This program is short. Unfortunately, useful programs

are much longer. Programs of 300 instructions, 3000 instructions, and even 10,000 instructions are common.

Invented Words, Mysterious Instructions

Programs are unusual documents. They're heavy reading in both senses of the word. They are hard to read because programs are not written in English, nor are they really written in a programming language. Let's look at the short BASIC program. Not counting line numbers and comments, it contains eight words and notations provided by BASIC: LET, =, PRINT, LET, =, +, GO, and TO. I invented the other seven words and numbers for the program: J, 0, J, J, J, 1, and 30. This is not unusual—in a typical program, almost half of the words are invented for that program or for a collection of related programs.

Besides invented words, programs contain mysterious instructions that the reader must decode. For example, line 40 of the BASIC program means "increment J" yet says "LET J = J + 1."

If a program were written once and then forgotten, an invented language wouldn't be a problem. Unfortunately, most programs are modified many times during their useful lives. Once the program is finished, it is set aside. Soon it needs enhancement or correction. The program is modified, then set aside again until the next change. Each time, the program must be read. Each time, its mysteries must be decoded and understood.

Echonet and Entries

With Echonet, you write programs as understandable phrases. Let's look at an example entry used in solving the Hanoi Tower Puzzle. Figure 1 diagrams the puzzle. The aim is to move a stack of rings from one tower to another tower. You can move the topmost ring of a tower to any other tower, but you cannot place a larger ring on top of a smaller ring. Listing 1 shows some of the entries used in solving the Hanoi Tower Puzzle. Each entry has an entry name shown in bold type and an entry definition written underneath. (In the following discussion, I have italicized words that have special meaning; for a glossary of these terms, see page 394.)

The first *entry* in listing 1 moves the topmost ring of any tower in figure 1 to any other tower. It is one step in solving the Hanoi Tower Puzzle. It has an *entry name* (**move TowerRing from HanoiTowerA to HanoiTowerB**), an *entry definition* (the three lines following the entry name), and *relocatable code* (Echonet stores relocatable code for executing the entry or *compiling* other entries).

The first entry definition in listing 1 is a sequence of three *instructions* with one instruction per line. Each instruction in the sequence starts at the same column. In this way, the visual appearance of an entry corresponds to its internal structure.

Each instruction in an entry definition *indicates* another entry. The three instructions in the first entry definition of listing 1 indicate the other three entries in *listing 1*. In turn, every instruction in these three entries indicates other entries (not shown) in an *Echonet dictionary*.

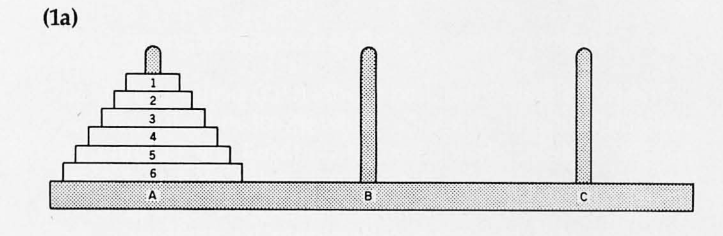
In an Echonet dictionary, every entry has a unique entry name. This makes all names unambiguous; given an entry name, both you and the computer can locate the entry.

Objects

In Echonet, words that start with a capital letter indicate *objects*. Table 1 lists the objects used in listing 1. Every object has an *object name* for indicating the object, *data* for describing the object, and *data types* for indicating entries by instructions. Objects are used as *arguments*, *parameters*, and data types.

Data typing in Echonet is a way of using objects to

(1a)



(1b)

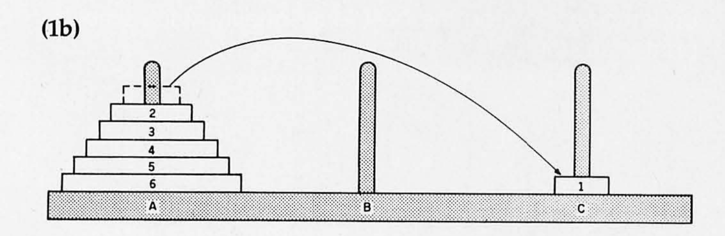


Figure 1: *The Hanoi Tower Puzzle. Figure 1a shows the initial position, figure 1b the first move. The object is to transfer all the disks to another tower without ever placing a larger disk on a smaller one.*

Listing 1: *Four entries used in solving the Hanoi Tower Puzzle. The name of each entry appears in boldface type, while its definition appears below.*

```
move TowerRing from HanoiTowerA to HanoiTowerB
  raise TowerRing above HanoiTowerA
  move TowerRing above HanoiTowerA to HanoiTowerB
  lower TowerRing onto HanoiTowerB

raise TowerRing above HanoiTower
  for ScreenLine from TowerRing. .position to above. .HanoiTower
    erase TowerRing on HanoiTower at ScreenLine
    draw TowerRing on HanoiTower at next Higher. .ScreenLine

move TowerRing above HanoiTowerA to HanoiTowerB
  on line above. .HanoiTowerA, move TowerRing from
    _ _ _ HanoiTowerA to HanoiTowerB

lower TowerRing onto HanoiTower
  for ScreenLine from above. .HanoiTower to onTopOf. .HanoiTower
    erase TowerRing on HanoiTower at next Higher. .ScreenLine
    draw TowerRing on HanoiTower at ScreenLine
```

Object Name	Data Type	Description
HanoiTower	HanoiTower	any tower in figure 1
HanoiTowerA	HanoiTower	any tower in figure 1
HanoiTowerB	HanoiTower	any tower in figure 1
ScreenLine	ScreenLine	any line of the screen
TowerRing	TowerRing	any ring on a HanoiTower

Table 1: *The objects used in listing 1.*

match instructions with entry names. Every object has one or more data types, and every data type is an object. An instruction matches an entry name if (1) all *name words* and *notations* in both instruction and entry name match exactly, (2) arguments and parameters occur at the same locations in both instruction and entry name, and (3) a data type of each argument is the same as a data type of the corresponding parameter. For example, the instruction "raise TowerRing above HanoiTowerA" indicates the entry **raise TowerRing above HanoiTower**, as does any instruction "raise XXXX above YYYY" where a data type of XXXX is **TowerRing** and a data type of YYYY is **HanoiTower**.

Operations

The third entry in listing 1 contains a . . (double dot), a __ __ __ (triple underscore), and a comma. The double dot makes the surrounding words ("above" and "HanoiTowerA") belong to an *operation*. The triple underscore makes the second line a continuation of the first line. The comma matches a comma in the indicated entry name.

Operations in Echonet are like value-returning function calls in a programming language. Just as with function calls, the results of operations become arguments to instructions. When Echonet looks up an instruction in an Echonet dictionary, it first replaces operations with a temporary object that is the operation's result.

In the third entry of listing 1, the operation "above. HanoiTowerA" is like a function call "getScreenLineAbove (HanoiTowerA)." It indicates the entry **ScreenLine := above. .HanoiTower**, and it is replaced by a temporary object, **TemporaryA**, whose data type is made to be **ScreenLine**. After replacing the operation, the entry's instruction would read "on line TemporaryA, move TowerRing from HanoiTowerA to HanoiTowerB," which indicates the entry **on line ScreenLine, move TowerRing from HanoiTowerA to HanoiTowerB**.

Indented Programs

The last feature of listing 1 is indentation that defines an *indented program*. For example, the entry **raise TowerRing above HanoiTower** indents two instructions below the first instruction. The first instruction is similar to a BASIC statement such as FOR I = 1 TO 4. It starts **ScreenLine** at "TowerRing. .position" and repeats the indented program until **ScreenLine** is "above. .HanoiTower." Each repetition erases a **TowerRing** at its current

position and redraws it one line higher. The first instruction contains two operations that indicate entries **ScreenLine := TowerRing. .position** and **ScreenLine := above. .HanoiTower**.

Because the first parameter of each entry is **ScreenLine**, and the data type of an indented program is **IndentedProgram**, the first instruction indicates the entry **for ScreenLine from ScreenLineA to ScreenLineB IndentedProgram**.

Entries in Echonet are like words in a dictionary. As with words, people will use them many times.

As described below, an indented program is compiled into relocatable code for an entry. A similar construct, not used in this example, is an *embedded clause*. Its main purpose is to embed conditional expressions into relocatable code (e.g., "while A = B do . . ." contains A = B as an embedded clause).

A Review of Entries

The entries in listing 1 illustrate several properties of Echonet:

- Echonet divides programs into components called entries and objects.
- Objects contain data. Object names start with a capital letter (e.g., **TowerRing**).
- Every entry has a multiword name that describes the entry (e.g., **move TowerRing from HanoiTowerA to HanoiTowerB**).
- Entries are defined by instructions that indicate entries and objects. Instructions may include operations or embedded clauses.

Entries in Echonet are like words in a dictionary. Entries are durable. As with words, people will use them many times. Instead of starting from scratch—inventing variable names, procedure names, and program names—Echonet users build upon an Echonet dictionary of entries and objects written by many people. Instead of encoding their programs in an invented language, Echonet users write their programs in a language made from entries.

Relocatable Code

Unlike words in a dictionary, Echonet entries contain relocatable code for execution by a computer. Echonet *compiles* relocatable code for an entry by (1) dividing the entry definition into instructions, (2) locating entries and objects indicated by the instructions, and (3) creating

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Listing 2: *Entries for demonstrating the Echonet compiler. The instructions in listing 2a clear and increment* **Count**, *while the instructions in listing 2b repeat the code of listing 2a.*

```
(2a)
nonsense instruction
  clear Count
  increment Count

(2b)
forever nonsense
  repeat
    nonsense instruction
```

Listing 3: *Entries for demonstrating the Echonet compiler (listed alphabetically). The entries in listing 3a are indicated by instructions in listing 2. The entries in listing 3b are indicated by instructions in listing 3a. Entries in listing 3c are indicated by code instructions in listings 3a, 3b, and 3c; entries not listed here are preceded by "append."*

```
(3a)
clear Integer
  Integer <- 0

increment Integer
  Code_increment_16Bits of Count

repeat IndentedProgram
  label Loop
  do IndentedProgram
  go to Loop

(3b)
do IndentedProgram
  Code_do_program of IndentedProgram

go to Label
  Code_go_to_label of Label

Integer <- Number
  Code_set_16Bits of Integer to Number

label Label
  Code_define_label of Label

(3c)
CodeValue instruction
  execute during compile:
    append CodeValue to New_relocatable_code

CodeValue of Object
  execute during compile:
    append CodeValue to New_relocatable_code
    append Object to New_relocatable_code

CodeValue of ObjectA to ObjectB
  execute during compile:
    append CodeValue to New_relocatable_code
    append ObjectA to New_relocatable_code
    append ObjectB to New_relocatable_code

execute during compile: IndentedProgram
  Code_compiler_executes instruction
  do IndentedProgram
  Code_finish_executes instruction
```

new relocatable code from relocatable code stored with each indicated entry.

When Echonet compiles relocatable code for the first entry in listing 1, it concatenates relocatable code from three entries (**raise TowerRing above HanoiTower, move TowerRing above HanoiTowerA to HanoiTowerB**, and **lower TowerRing onto HanoiTower**) and stores the new relocatable code into a fourth entry (**move TowerRing from HanoiTowerA to HanoiTowerB**). The resulting relocatable code can execute directly. It doesn't need an operating system or an interpreter. It is like a program stored on a disk, but with two advantages: it can execute anywhere in computer memory, and other entries can use it for compiling new relocatable code.

Compiling Relocatable Code from Relocatable Code

The following will describe how Echonet compiles relocatable code. Listing 2 shows two entries: one called **nonsense instruction**, which clears and increments a count, the other called **forever nonsense**, which repeats "nonsense instruction" forever. Listings 3a, 3b, and 3c show entries indicated by these instructions. Table 2 describes all objects used in the demonstration.

Relocatable code for an entry is a sequence of code instructions. The sequence is compiled by concatenating shorter sequences.

Relocatable code for an entry is a sequence of *code instructions*. The sequence is compiled by concatenating shorter sequences together. These shorter sequences were compiled by concatenating still shorter sequences together. The shortest sequence is a single code instruction. If you look at the definition of an entry, the definitions of each instruction, and the definitions of the instructions of the definitions of each instruction, you will in due course find code instructions. If you look at the *code* for an entry, you will find relocatable code.

Note that the entries in listing 3c reference each other. Echonet can have circular references because the meaning of an entry is different from its definition. The former is relocatable code while the latter is readable text. This difference distinguishes Echonet from programming languages such as FORTH and Smalltalk and from macroprocessors used with assembly languages.

Compiling an Entry

Echonet compiles an entry by concatenating relocatable code indicated by instructions. Let's see how Echonet compiles **nonsense instruction** (from listing 2).

Step 1: The compiler looks up the first instruction,

Object Name	Data Type	Description
Code_compiler_executes	CodeValue	start compiler execution
Code_define_label	CodeValue	define a label
Code_do_program	CodeValue	compile a program
Code_finish_executes	CodeValue	finish compiler execution
Code_go_to_label	CodeValue	branch to a label
Code_increment_16Bits	CodeValue	increment a 16-bit value
Code_set_16Bits	CodeValue	set a 16-bit value
CodeValue	CodeValue	a data type that represents a numeric value for selecting a code instruction
Count	Integer	an integer counter
IndentedProgram	IndentedProgram	a data type that represents a sequence of indented instructions
Integer	Integer	a data type that represents a 16-bit value
Label	Label	a data type that represents a location's label
Loop	Label	a label for looping
New_relocatable_code	RelocatableCode	a buffer for building relocatable code
Number	Number	any numeric literal
Object	Object	a data type that represents any object in Echonet
ObjectA	Object	an Object
ObjectB	Object	an Object

Table 2: *The objects used in listings 2 and 3.*

"clear Count." This instruction indicates **clear Integer** (listing 3a) because **Integer** is the data type of **Count**. The compiler appends the relocatable code for **clear Integer** to the new relocatable code. It replaces the parameter **Integer** with the argument **Count**. The resulting code is:

new relocatable code
relocatable code for "Integer <– 0"

which after parameter replacement produces the same code as:

new relocatable code
Code_set_16Bits of Count to 0

Because **Count** is not a parameter of **nonsense instruction**, the compiler allocates **Count** as the first temporary value in **nonsense instruction**.

Step 2: The compiler looks up the entry for "increment Count" and finds **increment Integer** (listing 3a). It appends this entry's relocatable code to the new relocatable code and replaces the parameter **Integer** with the argument **Count**:

new relocatable code
Code_set_16Bits of Count to 0
Code_increment_16Bits of Count

Step 3: The compiler finishes the code and stores it with **nonsense instruction**. The result is:

relocatable code for— **nonsense instruction**
Code_set_16Bits of Count to 0
Code_increment_16Bits of Count

The entry **nonsense instruction** is no different from other entries; after an entry is compiled, it contains relocatable code. This code can be executed or used for compiling an entry. You execute an entry by writing the entry's name and pressing the function key labeled Do. If you typed in the words "nonsense instruction" and pressed Do, Echonet would look up the entry named **nonsense instruction**, load the entry's relocatable code, and execute the loaded code.

Compiling an Entry with an Indented Program

In listing 2b, I used "nonsense instruction" for defining **forever nonsense**. After compiling **nonsense instruction** Echonet has relocatable code for compiling **forever nonsense**.

Step 1: The compiler looks up the instruction "repeat" followed by an indented program. Because the data type of an indented program is **IndentedProgram**, "repeat" indicates the entry **repeat IndentedProgram** (listing 3a). Echonet had compiled this entry from three instructions:

relocatable code for—**repeat IndentedProgram**
relocatable code for "label Loop"
relocatable code for "do IndentedProgram"
relocatable code for "go to Loop"

which produced a sequence of code instructions:

relocatable code for—**repeat IndentedProgram**
Code_define_label of Loop
Code_do_program of IndentedProgram
Code_go_to_label of Loop

Step 2: The compiler appends the first code instruction of **repeat IndentedProgram**:

new relocatable code
Code_define_label of Loop

Step 3: The second code instruction of **repeat IndentedProgram** is "Code_do_program of IndentedProgram." This is a special code instruction that tells the compiler to start appending relocatable code for the indented program.

Step 4: The indented program of **forever nonsense** (listing 2) consists of a single instruction, "nonsense instruction." The compiler locates the relocatable code for "nonsense instruction" and appends it to the new relocatable code:

new relocatable code
Code_define_label of Loop
Code_set_16Bits of Count to 0
Code_increment_16Bits of Count

Step 5: The compiler has finished the indented program of **forever nonsense**, so it returns to the relocatable code for **repeat IndentedProgram**.

Step 6: The compiler appends the third code instruction of **repeat IndentedProgram**:

new relocatable code
Code_define_label of Loop
Code_set_16Bits of Count to 0
Code_increment_16Bits of Count
Code_go_to_label of Loop

Step 7: The compiler is finished with the relocatable code for **repeat IndentedProgram**. It returns to the definition of **forever nonsense** (listing 2). It doesn't find any more instructions in **forever nonsense**, so it stores the new relocatable code. The result is:

relocatable code for—**forever nonsense**
Code_define_label of Loop
Code_set_16Bits of Count to 0
Code_increment_16Bits of Count
Code_go_to_label of Loop

Now you can execute **forever nonsense** or use it in compiling another entry. If you typed "forever nonsense" and pressed Do, Echonet would load the relocatable code stored with **forever nonsense** and start the computer executing that code. On a Z80 microcomputer, Echonet would load:

Glossary of Echonet Terms

The following glossary defines the Echonet system by defining the important words used for describing Echonet. Because Echonet is a new way of looking at programs and programming, it uses many of these familiar words in new ways. All words defined by the glossary are italicized at some point in the main text.

argument: *the part of an instruction or operation that indicates an object. An argument may be an object name, an operation, an indented program, an embedded clause, a string, or a number. For example, the operation "Count + 3" has two arguments: object name* **Count** *and number 3.*

code: *data that defines a sequence of computer instructions. For example, code 60 in a Z80 microprocessor increments the accumulator.*

code instruction: *the smallest unit of code that Echonet can execute or use in compiling an entry. A code instruction is identified by a numeric value called a "code value." A code instruction contains data that describes its arguments. Relocatable code is a sequence of code instructions.*

compile: *to generate relocatable code from an entry definition and an Echonet dictionary. Echonet compiles relocatable code from relocatable code stored with entries indicated by instructions and operations.*

data: *a bit string stored in a computer or stored on computer-readable media. A bit string is a sequence of ones and zeros that encodes a sequence of numeric values. Everything in Echonet is ultimately represented as data stored in an Echonet dictionary.*

data type: *an object assigned to objects and operations that is used for indicating entries with instructions and operations. For example, the object* **TowerRing** *is a data type for the objects* **TowerRingA** *and* **TowerRing**. *This allows the instruction "draw TowerRingA" to indicate the entry* **draw TowerRing**. *Users assign data types to objects when they define an object.*

Echonet dictionary: *a dictionary of entries and objects accessed by unique entry names and unique object names. An Echonet dictionary stores entries and objects for a user and for groups of users. An Echonet dictionary may contain hundreds of thousands of entries and objects.*

embedded clause: *part of an instruction identified by an embedded-clause pattern. An embedded clause is an argument whose data type is the object* **EmbeddedClause**. *On compilation, an embedded clause is passed as text to the indicated relocatable code.*

embedded-clause pattern: *a sequence of name words, notations, and textual classes. For example, "while any-clause do" is an embedded-clause pattern.*

entry: *an entry name, an entry definition, and data. Many entries contain relocatable code for execution or for compiling other entries. An Echonet dictionary stores entries.*

entry definition: *either text or a sequence of instructions. An entry definition describes an entry. The Echonet compiler turns an entry definition into relocatable code.*

entry name: *a sequence of name words, notations, and object names. Instructions and operations indicate entries by entry names. Object names in an entry name indicate parameters. Each entry name is unique within an Echonet dictionary.*

```
Loop:                 ;;repeat
  ld hl , 0           ;;  nonsense instruction
  inc hl
  jp Loop             ;hl = Count
```

The values of **Count** would be 0, 1, 0, 1, 0, 1, 0, 1, etc.

Discussion

I named Echonet after the Echo 1 satellite, which, in 1960, introduced me to information technology. At that time, Echo 1 reflected messages from earth. Now, Echonet reflects and captures ideas for computer programs.

Research on Echonet started when I first saw assembly-language listings produced by an optimizing ALGOL compiler. Such listings, especially those for nonarithmetic programs, were verbose and convoluted. By studying these listings, I learned that high-level programming languages did not accurately specify computer actions.

Echonet resulted from my search for a programming system that could symbolically represent any sequence of computer actions. The first breakthrough was deciding to make entry names the grammar for instructions. The second breakthrough was separating entry definitions from relocatable code. This removed the need for built-in instructions. The third breakthrough was using entries as Echonet's user interface.

One of my guiding principles was to accept the fundamental differences between people and computers. For example, computers can compute and store data far better than people can, while people recognize similarities and differences far better than computers can. The Echonet compiler connects the two by automatically translating from the personal world of symbolic entries and objects into the computer world of data and executable code. ■

Brad Barber runs Echo Systems Company (POB 5192, Westport, CT 06881), a one-person research firm. He recently joined ITT Programming as part of a research group that works on coordination systems.

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indented program: *an indented sequence of instructions below another instruction. An indented program is an argument of the preceding instruction. The object* **IndentedProgram** *is the data type of an indented program.*

indicate: *to select an entry with an instruction or operation. Also, to select an object by matching text with an object name. An instruction or operation indicates an entry when it matches an entry name. Before matching, Echonet replaces arguments and parameters with data types. If a match fails, Echonet trys other data types for the arguments.*

instruction: *one line of text. An instruction can indicate an entry. Many instructions indicate entries that have relocatable code. Instructions often contain arguments.*

name word: *a sequence of letters, digits, and underscores that starts with a lowercase letter. Name words occur in embedded-clause patterns, entry names, and operator patterns.*

notation: *printable characters other than letters and digits. For example, "$" and "= >" are notations.*

number: *a sequence of digits. A number has the data type* **Number**. *For example, the instruction "print 123" indicates the entry* **print Number**.

object: *an object name, data types, and data. The same object can act as parameter, argument, or data type, depending on its use. An Echonet dictionary stores objects.*

object name: *a sequence of letters, digits, and underscores that starts with a capital letter. An object name is unique within an Echonet dictionary. Instructions and entry names indicate objects by object names.*

operation: *part of an instruction that matches an operator pattern. An operation is an argument to an instruction or operation. Operations indicate entries whose entry names start with a parameter followed by :=* . *The data types of an operation are the data types of the initial parameter. For example, the instruction "print Integer + 3" contains the operation "Integer +3." This operation indicates the entry* **IntegerResult := Integer + Number** *which has an* **Integer** *data type. So, this instruction indicates the entry* **print Integer**.

operator pattern: *a sequence of name words, notations, and textual classes. For example, "any-object-name + any-object-name" is an operator pattern. Operator patterns show the operations in an instruction.*

parameter: *an object indicated by an object name in an entry name. For example, the entry* **print Integer** *has a parameter* **Integer**. *In an entry definition, parameters become arguments to instructions and operations.*

relocatable code: *a sequence of code instructions that Echonet can execute anywhere in computer memory. Echonet uses relocatable code to compile new relocatable code. Relocatable code may contain several thousand code instructions.*

string: *text enclosed by quotes. A string has the data type* **String**. *For example, the instructions print "this is a string" indicates the entry* **print String**.

text: *characters that can appear on a page or a screen. Text may be 212 characters wide.*

textual class: *a pattern element that identifies an object name, a name word, a clause, end of line, or start of line; textual classes occur in operator patterns and embedded-clause patterns.*

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Computer Crime: A Growing Threat

The proliferation of home computers has eased illegal access to small-business computers and corporate mainframes

by Collen Gillard and Jim Smith

In this article, Collen Gillard and Jim Smith describe two facets of the computer crime problem. Gillard begins by introducing background information based on documented cases of computer crime. The names of individuals and companies have been changed to protect their privacy. Starting on page 412, Smith discusses the technical requirements of a security system designed to deter the computer criminal.

Few businesses can operate today without the help of a computer. Computer-stored data, once the province of wealthy corporations, is now available to small-business owners as well, thanks to the falling costs of microcomputers and the development of easy-to-use applications software. Unfortunately, however, this same machine that provides businesses with a competitive edge also places them at the mercy of a new type of lawbreaker—the computer criminal.

Consider this case from the files of the International Association of Computer Crime Investigators (IACCI), headquartered in Burlingame, California:

In San Jose, California, in 1982, a successful software company lost a key employee in a dispute over a pay raise. The disgruntled ex-employee soon began to market a similar software line. To develop a customer base, he merely turned to his home computer, equipped with a modem, for easy access to his former employer's confidential files.

From the privacy of his home, he dialed the former employer's computer and, discovering that his file had been deactivated, tried those of company employees, guessing at their passwords. After a few attempts, he penetrated the system and located proprietary product-development information as well as customer lists. In minutes, his chief competitor's business secrets were flowing from the printer in his study.

The former employer's customers soon revealed that he was approaching them with products similar to those of his former employer, but at attractive discounts.

Knowing that their product data and customer records were confidential, the company's executives could draw only one conclusion—their computer system had been tapped. Fortunately, though, because a secret monitoring device was in place, the intrusion was identified and, after a detailed investigation, the ex-employee was apprehended and prosecuted. However, during the investigation, service for more than 50 key customers was interrupted. This case is unusual because it was detected and prosecuted. The vast majority of intrusions go undetected, and an untold number of crimes are therefore not prosecuted.

The Potential for Damage

Trade secrets and marketing data are not the only types of material threatened by the access home computers and remote terminals provide. The government stores sensitive information on its military installations, manpower, and defense plans in computer systems. Are these top-secret files safe from unauthorized access?

In the recent film, *WarGames*, a teenage computer whiz nearly launches World War III while playing what he believes to be a simulated war game with a remote computer.

Although parts of the plot may be farfetched, the film highlights some current realities: namely, the ease with which dial-up access is gained to an airline reservations system and a bank. Moreover, months before the film was released, a group of 12 teenagers from Milwaukee managed to gain access to computers in the nuclear-weapons laboratory at Los Alamos, New Mexico. The Milwaukee teenagers used procedures for dial-up entry and password search not unlike those used by the high-school student in the movie. In wry homage to the movie after its release, one of the Milwaukee students began to sign into the Los Alamos computer as "Joshua," the password that enabled the computer whiz in the film to log onto the game-playing computer.

A disturbing aspect of the Los Alamos raid is a statement from one of the youths whose knowledge of the machines consisted of a six-week computer course. He described the break-in as "really easy to do. All you have to find is someone with a computer and modem. And we all have computers and modems."

The youths, aged 15 to 21, had logged onto the Los Alamos system

through dialing into the Telenet network. Such a national network requires only a local telephone number to get into the service and an account number to use it.

As one youth summed up the situation, the problem occurred because of the vulnerability of the computers. He admitted that "it got out of hand," but added that, "it's not our fault, either. There's no security in it . . . It didn't take too much intelligence to get into the things."

In this case, the violated systems contained no classified material. But what if the perpetrators had been more threatening and the computer files more sensitive?

The case of the Milwaukee youths, who also admitted breaking into business and corporate computers, proves that illegal forays into computer systems can be as simple as the acquisition of a telephone number and a password code. Dial-up penetration of computer systems today is a serious threat to businesses large and small. For large corporations and institutions like the U.S. government, such threats can have far-reaching consequences.

In a similar case from a year ago, a student who was enrolled at Carnegie-Mellon University in Pittsburgh demonstrated the vulnerability of the military's computer systems from his dormitory room when he broke into the U.S. Department of Defense computer network. From there, he moved onto an Air Force computer system. When discovered and questioned as to his intentions, he said he was gathering "missile plans" to publish in an underground newsletter called *TAP*.

Geoffrey Goodfellow, a systems analyst with Stanford Research Institute (SRI) International in Menlo Park, California, explains: "Once someone accesses a national network like the one used by the Department of Defense, that person has unlimited access to any of the computer systems belonging to the universities or corporations hooked to the network. In this case, the student from Carnegie-Mellon wandered in and



Photo 1: *The Secure Access Unit works with a telephone and modem that provide direct-dial access to a computer. It calls back a remote terminal to verify that the user is requesting access at an authorized location.*

out of systems all over the country, accessing directories, reading files—just, as the student put it, 'browsing around for something interesting.' "

The point? Casual intruders can have two effects: while browsing, they can innocently destroy records and alter operating systems; and, when they *do* find interesting information, the temptation to steal it is strong.

Fear of Publicity Cripples Awareness

Although most authorities on computer security won't speculate on how much computer criminals steal annually, all agree that the dollar figure is far into the millions. Charles Wood of SRI points out, "We will never know how many crimes go undetected and how many unreported. Many firms don't want the publicity, nor do they want to encourage other thieves. Banks, in particular, shun publicity. There is nothing like this kind of publicity to foster loss of confidence in your firm's ability to handle security."

Although solid data on losses resulting from computer crimes is not available, statistics from the F.B.I. are still illuminating. They reveal that the average amount stolen in an armed robbery is $3000; by embezzlers, $19,000; and by computer thieves, an astounding $100,000.

Doug DeVries, DP security manager at Hewlett-Packard Co., warns that unless businesses act on the problem, losses from computer crime could increase in the future. Experts recommend computer security systems to protect highly vulnerable systems and curb computer crime.

The fast-moving field of computer technology has surpassed computer law and its associated areas, particularly criminal investigation. According to Bruce Goldstein, computer criminologist and founder of the IACCI, "In all the world, approximately 200 police investigators have completed technical training in this special type of criminality. Present databases indicate a far-reaching problem beyond the scope of this limited number of individuals." Indeed, as many computer security analysts admit, part of the problem lies just in *anticipating* the locations of a system's vulnerability.

At one time, corporate officials thought that the highly technical nature of computers ensured their security. After observing how vulnerable those systems actually are, firms are now forming "tiger teams" to find holes in their computer security systems.

These teams are composed of computer experts in systems analysis, operating systems, applications programming, and physical security. They take a "no holds barred" approach and attack the integrity and security of an entire computer system in order to find exposures and vulnerabilities. Such teams are discovering that a multiplicity of solutions is necessary to plug security holes. Technical products include encryption devices, password and software systems, and a call-back device such as the Secure Access Unit (SAU) and its multiport cousin, the Secure Access Multiport (SAM) from a San

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A Different Kind of Culprit

In a sense, computer crimes do not differ significantly from more traditional crimes. As SRI computer security specialist Donn Parker and his associate Charles Wood explain, such crimes as fraud, theft, larceny, embezzlement, extortion, sabotage, espionage, and violation of privacy have the same results regardless of the means used. Yet computer crime *is* different. "The occupations of the perpetrators, the timing of the acts, the geographic locations of the parties involved, and the environments in which these acts take place have all changed," say Parker and Wood.

Computer criminals, for example, are generally white-collar, well-educated professionals without police records. When caught, many have based effective defenses on the claim that their ethical judgment was undermined by the impersonal nature of their act.

In his book, *Crime by Computer*, Donn Parker states that the most common characteristic among computer criminals is that, as formerly honest people, they have difficulty accepting their dishonesty. Hence, they work hard to rationalize their crimes. For example, they claim they don't steal from people, only from corporations; or, because they don't like their bosses, they say they embezzle more for revenge than personal gain and try to justify their retaliation.

Computer embezzlers often prefer to see themselves as borrowers—not thieves—who became criminals without intending to. They often have problems with alcoholism, drugs, or financial responsibilities, says Parker, adding that computer criminals are generally people who by nature seek easy solutions to complex problems.

In August of 1977 the *New Yorker* told the story of an accountant who embezzled more than $200,000 a year from the produce-packing company where he worked. "I had a very tough job at best, organizing the accounts of a company run by people I didn't like," he said.

When he didn't get the bonus he'd been expecting, he warned, "There's one guy in this organization you shouldn't fool around with." He said his motive for embezzling was revenge.

A more recent case involved a former Federal Reserve Bank employee who illegally accessed the bank's database. The culprit was able to dial up using the password of an existing employee to obtain confidential data on money supply and interest rates.

The Hacker

For many young computer enthusiasts, though, breaking into a computer system is just a game. Such electronic whiz-kids—"hackers" in computer lingo—say they break in for the challenge, or "because it's there."

Consider, for example, the case in which workers at the New Jersey Board of Education turned on their terminals one morning to find their

normally friendly machines with new foulmouthed personas. In addition, the board's files had been wiped out. Security operators finally located the perpetrator—a 15-year-old.

Unauthorized computer users and their motives fall into three groups: employees (for embezzlement or vengeful destruction), hackers—high-school and college students (for malicious reasons or out of curiosity), and computer users from outside a company (committing grand theft). Alan Fielding meets what security experts consider the profile of the curious hacker turned by temptation to illegal profit.

When the law caught up with Fielding, the 21-year-old computer whiz had already illegally made a million dollars from a telephone supply company that he set up.

While studying engineering at U.C.L.A., Fielding developed intimate knowledge of telephone company technology. Referring to telephone company discards he had collected since youth, he developed a scheme to obtain equipment from a California telephone company and resell it. He had used one telephone company's computerized ordering system to build a lucrative illegal business. He ultimately was prosecuted and convicted.

Fielding is an example of what many computer security experts fear most: the high-school hacker who turns to bigger things. Massachusetts Institute of Technology programmer Richard Stallman defines a hacker as "someone who knows computers inside and out, gets a nonprofessional amount of fun out of them, and can appreciate the irony and beauty of a program."

As applied to students, this description must also include an element of youthful and undisciplined exuberance. As Wood puts it, "Kids are often motivated by challenge or the respect of their peers. It's like joyriding in cars used to be. And, like joyriding, it's mostly a male phenomenon. Our obvious concern is, what happens when these kids grow up and mischief turns to personal gain?"

SRI's Geoffrey Goodfellow broke into his first major computer network at age 15. He calls himself a hacker—a term, he notes, that once *had less* derogatory connotations.

Although Goodfellow distinguishes the malicious from the mischievous or harmless hacker from the more dangerous computer criminal, security officials take a dim view of *anyone* who romps through company files. Such innocent romps, they say, sometimes cause as much damage as intentional assaults.

The Basic Tools

Fielding is just one of many who have discovered that the phone lines, a modem, and a home computer provide a computer wizard with all the burglary tools necessary to dial up and break into a computer system. From there, the possibilities are as unlimited as your imagination and skill and the information a computer system stores.

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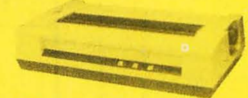
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Computer security experts have identified both legitimate and "cracker" bulletin boards. The "cracker boards" are fed and manned by "T.H.E.M.," as the group is called in computer crime circles. T.H.E.M. is an acronym for Telecommunications Hackers, Embezzlers, and Manipulators. There are more than 800 of these boards operating today in the United States, according to IACCI founder Goldstein.

The computer criminal, then, has all the needed tools: hardware to use in illegal access and, via the bulletin boards, access codes to computers across the country.

The Legal Issues

Newspaper and magazine reports have sensationalized crime committed with computers. Many articles claim that the nature of the medium makes detection of unauthorized use impossible, or that even if such use is detected, it is impossible to prove in court. These claims are the subject of much debate.

Legislators and the courts are beginning to take computer crime very seriously. Some states, particularly those with industry bases in high technology, have passed some legislation helping to govern computer crime; indeed, bills have been proposed in the U.S. House of Representatives that may bring clarity to a multitude of complex and interrelated questions. Sentences may one day reflect the magnitude of the offense.

Unfortunately, the legal process takes time, whether at the state, local, or national level. And victims and potential victims cannot wait for those channels to yield solutions to computer-crime-related issues.

If the problem arises through technical vulnerabilities, the obvious solutions are to be found on a technical level. Technical innovations now are available that can limit vulnerability and make computer systems with dial-up access much easier to protect.

Limiting Computer Access

In the past, log-in passwords gave computer systems at least superficial protection from outside dial-up intruders. A "gray market" in these passwords, however, has weakened the protection those words once afforded. Computer gray markets, DeVries explains, operate out of underground newspapers and electronic bulletin boards, which advertise the availability of such items as telephone numbers, log-in or user names, and passwords for company computers. Such information is available in trade for similar means of access.

DeVries points out that the larger the computer system and the greater the amount of information it stores, the harder it is to supervise those using it. A system's ports of access, he says, are the weak links in a system's security.

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Protecting Information from Unauthorized Access

A variety of security techniques have emerged to combat the costly and destructive types of computer crime described in this article. The purpose of each of them is to limit access to such authorized users as employees who are traveling or working at home.

Communication with a computer from a remote terminal is usually carried out via a direct-dial telephone network. Although many online terminals are connected to the host via dedicated or private-line telephone circuits, an employee working away from his office normally accesses the company computer through the standard local and long-distance telephone network. This arrangement permits the greatest flexibility at the lowest cost.

ple, is a device designed to protect single-port systems; its recently introduced counterpart, the Secure Access Multiport (SAM), guards multiport systems. These products and others are designed to prevent unauthorized access to a system.

DeVries says that one advantage of the SAU is that it limits dial-up access to previously selected dial-up sites. Like an answering service, it screens callers before they reach the company's computer modem and log on. (See the text box on this page for details.)

Callers use a push-button telephone to send the SAU a six-digit Location-Identification Number (LIN). The device receives it, hangs up, and checks its memory for the authorized six digits.

Like an automatic electronic watchman, the SAU and the SAM answer all incoming calls to the system and provide call-back access only to those who are at authorized locations.

Within a matter of seconds, the device answers the call and receives the six-digit LIN via a push-button telephone. At this point, the device emits an acknowledgment tone and disconnects.

The device searches its call-back directory for a preprogrammed telephone number of the authorized location. It then calls back. At the authorized site, the user answers the call, enters a one-digit connection code, and is connected to the system. If the incoming call came from an unauthorized site, the attempt to breach the security is thwarted, and, in the case of the SAM, an audit trail logs the unsuccessful attempt. Additionally, the audit trail monitors successful connections and reports on modem and line operation.

Phone-line access to company systems permits thefts of software, files, money, and materials from any distance, DeVries notes. "The tremendous proliferation of personal computers, modems, and hacking skill means that there are statistically just that many more people out there with the capability of breaking into company systems," DeVries says. "Today there are more and more people who know how to program, how to get passwords, how files and directories look, and who just might see something interesting on your system. With just passwords, someone



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in Timbuktu would have everything he needed."

"Computers are dumb and accept at face value any material put to them," Goodfellow says. For this reason, he is dissatisfied with the password system of protection. "It's too easily broken, or obtained, to provide security to something as valuable as a computer system," he explains. "People often have ridiculously obvious passwords, like their initials [or] wife's, children's, or dog's names. And if it isn't sufficiently mnemonic, they'll write it down somewhere on their desk. Obviously, for this last reason, it's impractical to assign them."

And as sensational news stories have shown, reliance upon passwords to block outsiders is foolhardy and only a partial step toward reliable security. A first step might be to remove one's computer's telephone number, thus limiting the computer's exposure to the finite number of telephone numbers in its directory.

As Goodfellow says, "What's nice about the SAU is that you know exactly who's getting in, and you can stop him at any time. You can stop ex-employees by removing their authorization numbers from the SAU directory."

A View from a Computer Criminologist

"In the 1980s," notes IACCI Executive Director Goldstein, "almost all phases of our lives have been computerized—from offices to assembly lines to farms to homes, we are increasingly in contact with computer information networks.

"We have made ourselves even more vulnerable by allowing not only our internal losses to cripple us—we have opened this door to the corporate vaults (our computer-stored data) to a dial-up criminal who can rob us from the safety and comfort of his home computer. *WarGames* of another ilk is a reality."

Goldstein added that, "One recommendation that represents a realistic appraisal of the situation is to consider a viable telecommunications device to limit or control access to the computer."

Easy Access: Curse Or Boon?

Easy access, while a blessing to the computer user away from the office, also makes the computer vulnerable to intruders. Through the same direct-dial access port that allows a company's outside personnel to access the computer, so can a computer hacker dial in and attempt to access private and sensitive information. To prevent the loss of important data, many companies avoid direct-dial telephone access into their corporate computers. But for those companies that permit telephone access, several hardware and software devices and systems aid in preventing and detecting unauthorized usage.

Improving Security Tools

One of the simplest and oldest ways to protect a direct-dial interface port is to use an unpublished telephone number. This technique usually prevents unauthorized company personnel from dialing into the computer just to have fun. However, an unlisted telephone number is a poor security solution. Keeping a number secret and changing it as needed pose difficult problems. But perhaps the biggest drawback of using unlisted numbers is the fact that a serious attempt to discover the direct-dial-access port of a computer requires no knowledge of the telephone number itself. A smart terminal or personal computer system equipped with a simple control program and the appropriate modem and automatic dialer circuitry can be used to dial telephone numbers at random and identify those numbers that answer with the conventional modem carrier tone. This renders even an unlisted telephone number useless.

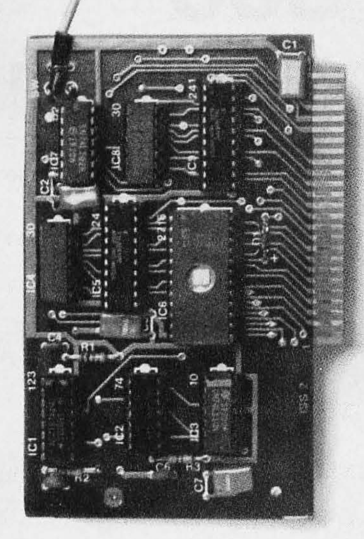
The most popular security approach in use is the password system. This software technique requires a user to enter a password to gain access to a computer's operating system. The password, like an unlisted telephone number, is kept secret and often reassigned periodically to prevent unauthorized use. And, like the unlisted telephone number, the secret password is vulnerable to random or systematic at-

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tack using a personal computer. A dedicated hacker using an unrelenting trial-and-error technique can often uncover a valid password and unlock a company's computer software system with little or no effort. In fact, the major problem with a password approach is that users often assign very simple and easy-to-remember (and guess) passwords that often go unchanged for months and even years.

In fact, it is not uncommon for an employee to leave a company and find that the password he was assigned is still completely valid long after his departure.

Related to the password approach is a hardware solution known as the pass-through technique. With this method, after an incoming call is answered, the calling party enters an identification code, usually using the Touch-Tone telephone to enter the data. A valid code causes the pass-through circuitry to establish a full connection between the caller and the computer modem. A normal connection sequence then occurs. The relative ease of determining a secret code and gaining entry makes this system as susceptible to failure as the password approach is.

Although these three approaches are effective for individual situations, none provides solid protection for the direct-dial computer-access port. Yet all are widely used. They should not be totally scrapped, but instead used to provide layers of security according to the requirements of the individual installations. Unpublished telephone numbers and passwords are valuable defenses even if additional security equipment and software are in place.

An Emerging Technology

Several new techniques aimed at limiting computer access are emerging. Four are data encryption, voice and fingerprint recognition, and retina scan. The first is not actually an access-control method but a message-coding technique. Voice and fingerprint recognition, on the other hand, are normally used as a user-unique "password" to control computer access.

The accepted method for data encryption is the National Bureau of Standards' Data Encryption Standard (DES). This technique scrambles the transmitted data by iterative multiplication with a randomly generated 56-bit key. An additional 8 data bits in the key are provided for parity checking, thus making the DES key 64 bits long. DES keys are themselves highly secret and must be guarded as carefully as passwords.

The major drawback to data encryption is the high cost to implement even a simple system. An encrypted communications channel requires DES circuitry at both ends of a link. At the host computer, where the number of data-access ports is limited, the added cost of encryption equipment is small compared to the cost of the entire system, and the DES equipment is easily justified. Because similar equipment must also be installed at each terminal used to access the host computer, the resulting cost to modify these terminals for data encryption can easily exceed the

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terminal's initial cost by a factor of two or more. Furthermore, management of a DES key can prove difficult; a terminal with DES key codes installed is an easy target for an unauthorized user and thus provides little security. The implementation of data encryption often only shifts the data-security problem from one of controlling computer access to controlling terminal use.

Two other security techniques, voice and fingerprint recognition, are relatively new, expensive, and unproven, but they could prove useful in the future. For use in monitoring dial-access connections, voice recognition is more attractive than fingerprint verification because it does not require the use of additional hardware on remote terminal equipment. The purpose of both methods, however, is the same: to identify the user.

Tracking Attempts to Breach the System

To monitor the effectiveness of any of these security methods, a computer system should also generate an audit trail, a record of the transactions it makes. A typical record would describe the telephone line or lines involved in each connection, the time and duration of each connection, and the access codes used to establish the connection. A log of successful and unsuccessful access attempts should also be included. This record, coupled with the call accounting records generated by most of the modern PABX and telephone-company switching systems, can be invaluable in tracing computer criminal activity.

User vs. Location Authorization

The security approaches described thus far are used to identify the user on a direct-dial access port into a computer. A second, highly accurate technique identifies the user's location rather than the actual user or his terminal. Because most legitimate users access a company computer from home or a company field office, location identification can be an important way to spot an unauthorized user.

The Secure Access Unit (SAU) provides the means to implement this technique. It verifies the location of a direct-dial access request and denies access if the call originates at an unauthorized location. This simple, low-cost hardware solution operates outside of the host computer equipment and its dial-access modems. The latter feature is important because many computer security problems stem from the unauthorized alteration of computer software or data by personnel who have access to the machine through unprotected online terminals. Once system software has been altered, the security control on outside access may be compromised.

The SAU telephone-line interface is housed in a package that's 8.5 by 11 by 2¼ inches deep (see photo 1 and figure 1). It is installed between the direct-dial telephone network and the modem on a computer-interface port; it can also be used on the remote-access port of any remotely controlled equipment and works with any conventional modem or ac-



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cess controller that functions with voice-band data communications. Typically installed on a wall in the telephone-equipment closet next to a computer room, the unit can alternatively be rack mounted in the computer room.

The SAU contains the circuitry needed to answer all incoming calls, accept a valid Location-Identification Number (LIN), and return a call to the appropriate location before a final connection is allowed. The return call prevents general unauthorized access by positively establishing the location of the calling party before allowing access to the computer. Note that the SAU identifies the proper location of a remote user but not his identity (unless the LIN is known to only one person). In general, the SAU would be used with several security measures on a system. Passwords, software partitioning, and even data encryption could still be required to ensure complete control.

The SAU comes with a directory of return-call telephone numbers—a master number and as many as 99 authorized-location telephone numbers. Each telephone number can be as many as 16 digits long. From the master location, usually a secured telephone, the 99 other numbers can be added, deleted, or modified.

The newly introduced Secure Access Multiport (SAM) can support 2304 users and interface as many as 64 telephone lines with one controller. Audit-trail record keeping, remote-access control of directory information, and unique line partitioning and return call routing options are also available for the multiple-line unit.

The SAU can be used to access small single-line systems and the SAM can be used for larger systems. Usually the SAU operates with one telephone line. Because it must control access into the data modem of the computer's interface port, it can function with any standard modem at any data rate. After allowing a user to access a protected computer, the unit becomes transparent during the actual data connection. The microprocessor-controlled device includes extensive self-test and maintenance

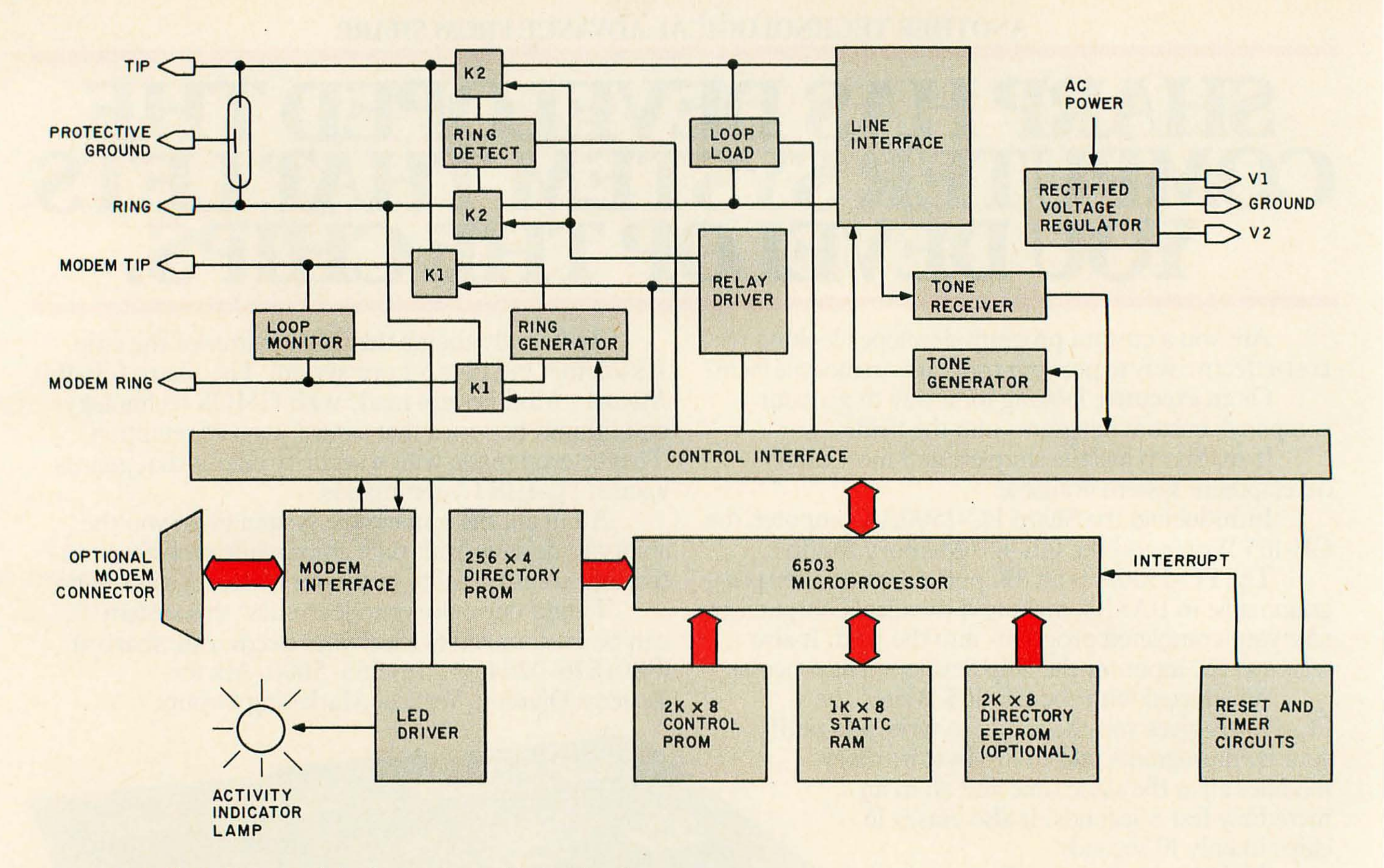


Figure 1: *A block diagram of the Secure Access Unit's circuitry.*

capabilities, fail-safe control of malfunctions, and remote testing features.

Figure 1 is a block diagram of the SAU's circuitry. The device normally derives power from a wall-plug low-voltage transformer. The circuit board is enclosed in a metal housing with a hinged-cover door that can be equipped with a locking latch.

The SAU interfaces the telephone line through the "TIP" and "RING" terminals. Detection of the ring current is accomplished with the block marked Ring Detect, an opto-isolator coupler detection circuit that provides high isolation between the telephone line and the SAU's control circuits. The 6503-based main controller analyzes the ring signal information and answers the incoming call by operating relay K2. Next, a DC loop load circuit block and an AC line interface block are connected to the TIP and RING terminals. The SAU is then prepared to receive the LIN as a tone code from the calling party.

After the SAU receives the LIN, a sequence of six digits, it checks the code against a table of telephone numbers stored in its directory. If a match is found, it uses the tone generator to send the user an acknowledgment tone and then monitors the DC loop conditions for the proper network disconnect signal to ensure that the user has properly hung up the telephone handset. If this network signal does not occur at the appropriate time, the SAU begins a forced disconnect procedure.

The SAU also terminates incoming telephone calls that do not result in a valid LIN code within a preset time period. This function prevents a caller from hanging on the line to tie up the device and the computer port it protects.

As depicted in the operational flowchart in figure 2, the SAU continues its security function by returning to an off-hook state and dialing the telephone number that corresponds to the valid LIN it received. After the user answers this return call and enters a one- or two-digit connection code, the SAU activates its associated modem and relay K1 to connect the user through to the host computer's modem. The SAU monitors the connection first through the normal line-interface circuit block to ensure a proper modem handshake sequence has occurred and then through the high-impedance loop-monitor circuit block to detect the completion of the call. When this call is complete, the SAU returns to its idle state, ready to receive the next call.

The SAU can interface the host computer modem in one of two ways. Because normal direct-dial interface ports are arranged with automatic answer modems, the SAU's primary interface arrangement is through the ring-generator circuit block; the unit is wired to the modem through the two terminals marked MODEM TIP and MODEM RING. When the SAU is ready to activate the modem, it synthesizes a high-voltage 20-Hz ring signal that it transmits to the idle modem. The modem, interpreting this signal as an incoming call, connects to the MODEM TIP and MODEM RING lines to answer the call. The SAU then operates the K1 relay and connects the modem to the normal TIP and RING telephone lines.

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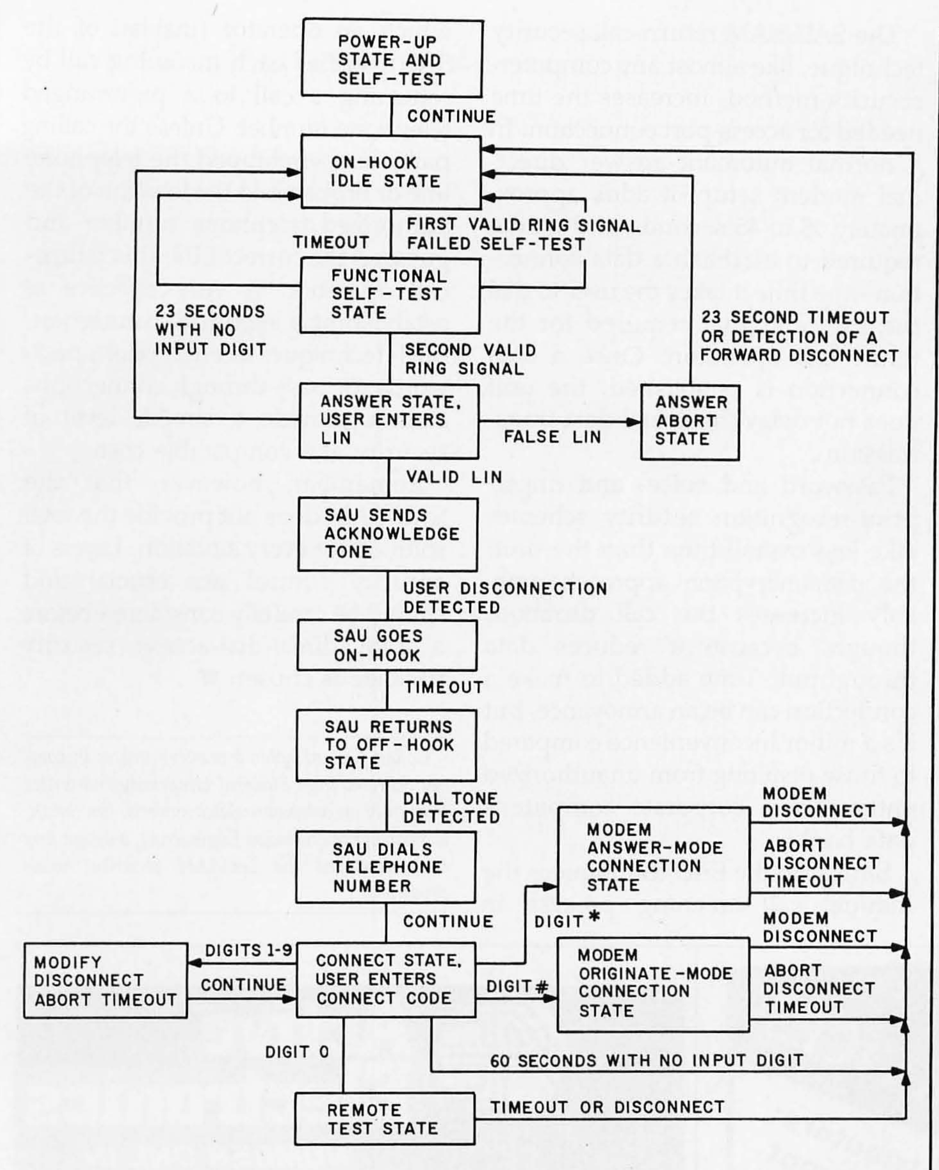


Figure 2: *This flowchart describes the Secure Access Unit's (SAU) operation. Note that if the unit receives an invalid (false) Location-Identification Number (LIN), it aborts the attempt to access the host computer and returns to the idle state.*

An auxiliary connector (marked in figure 1 as the optional modem connector) and the modem-interface circuit block provide additional control leads and functions to activate an originate-mode modem. In this interfacing scheme, the SAU connects the MODEM TIP and MODEM RING lines to the telephone lines while it operates a control lead to the modem. The modem is forced into the connection state—originate mode—and listens for the normal answer-tone carrier signal from the user's modem. After the connection is established, the SAU resumes its line-monitoring functions.

Several control and dialing features are provided in the SAU's software. For installations with full automatic modem equipment at both ends of the connection, the SAU can function without the need for a connection code from the user after the return-call operation is complete. Also, the device can be requested to dial out one of ten 16-digit prefix numbers before dialing a regular number from its return-call directory. This system has two advantages: it allows telephone numbers as long as 30 digits to be dialed, and the prefix numbers need only be entered into the directory once.

The SAU performs several self-tests before it answers an incoming call.

These include functional verification of the tone generator and receiver, tests of the telephone line loop voltage and impedance, tests of the connection veracity between SAU and the modem, and verification that the proper connection arrangement exists between the SAU and the telephone line. Should a test fail, the unit does not answer calls, thus guaranteeing that no malfunctions occur during the critical return-call operation.

In addition to performing self-tests, the SAU can be placed in a remote-test operating mode. Remote testing allows a reading of the directory serial number (not its contents), measurement of tone levels and frequencies from the tone generator, correct operation of the tone receiver, and verification of the connection wiring to the companion modem. As are all the SAU's operations, the remote-test state is protected by the return-call sequence to prevent unauthorized remote-controlled tampering of the unit.

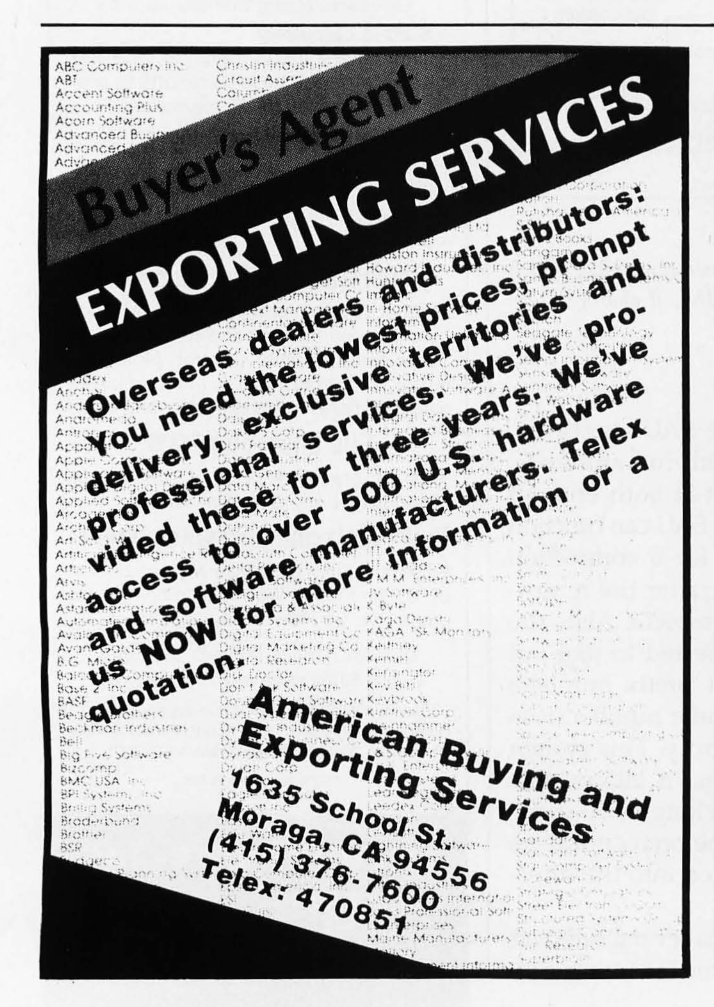
The SAU/SAM return-call security technique, like almost any computer-security method, increases the time needed for access-port connection. In a normal automatic-answer direct-dial modem setup, it adds approximately 15 to 45 seconds to the time required to establish a data connection—the time it takes the user to dial the LIN and that required for the return-call operation. Once a data connection is established, the unit does not delay the actual data transmission.

Password and voice- and fingerprint-recognition security schemes take less overall time than the unit; the data-encryption approach probably increases the call duration, though, because it reduces data throughput. Time added to make a connection can be an annoyance, but it's a minor inconvenience compared to those resulting from unauthorized entry into a corporate computer's data banks.

Similar to the SAU technique is the manual call-screening process in which an operator (instead of the SAU) verifies each incoming call by returning a call to a prearranged telephone number. Unless the calling party has wiretapped the telephone line or broken into the location of the authorized telephone number and guessed the correct LIN, this return-call operation is very effective at establishing a legitimate connection. Such techniques as encryption, passwords, or pass-through connections cannot provide a similar level of security at a comparable cost.

Remember, however, that the SAU/SAM does not provide the total solution for every situation. Layers of security control are crucial and should be carefully considered before a total direct-dial-access security package is chosen.■

Collen Gillard holds a master's degree in communications from Stanford University and writes frequently on computer-related subjects. Jim Smith is a partner in Omnicom Engineering, a design firm that developed the LeeMAH Security Access products.





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More Unix-Style Software Tools for CP/M

The CP/M Microtools include the most popular utilities available for the Unix operating system

by Christopher O. Kern

Microtools, a package of Unix-style utilities for the CP/M environment, testifies to the popularity of the Unix operating system and its utilities. The 26 programs in this package can be used with regular CP/M or with CP/M enhanced by Microshell, a command interpreter similar to the Unix Shell. Microshell replaces the standard console command processor (CCP) of CP/M and creates a Unix-like framework within which the Microtools programs run. Both Microtools and Microshell are distributed by the same company, hence it's not surprising that they work together.

The Microtools package is similar, in many respects, to another set of Unix-style software tools, called Unica, which I reviewed in a previous issue (see "Microshell and Unica: Unix-Style Enhancements for CP/M," December 1982 BYTE, page 206). There is some overlap between Microtools and Unica. For example, both products include pattern-matching programs modeled after the Unix grep family of utilities and both offer file-comparison programs based on the diff utility that is available on Unix systems (see listing 1).

The two products are guided by the same philosophy of small, general-purpose programs, as well. Both, for instance, provide a consistent command syntax. Options and parameters for the programs are specified in a similar manner for all the programs in each package.

The programs in each package are also designed to work together. Using temporary files, they can be combined in "pipelines" that read the output of one program into the input of the next program, as shown in listing 2c. Both packages feed the output from one program to a temporary file, from which the next program reads its input. That means that the time required to execute a pipeline is equal to at least the sum of the times required to run the programs individually. Unica is also capable of these composite functions.

Under Unix, which is a multiuser, multitasking operating system, the programs in a pipeline execute simultaneously. The system provides coordination and transfers data between them.

There are some important differences between Microtools and Unica, however. The Microtools programs are all designed to be compatible with the Microshell com-

At a Glance

Name
Microtools

Type
Unix-style utilities for CP/M

Author
Donald Graft
Microtool Software
POB 12
Naperville, IL 60566

Distributor
New Generation Systems Inc.
2153 Golf Course Dr.
Reston, VA 22091
(703) 476-9143

Price
$150

Format
Various CP/M floppy-disk formats

Computer
8080/8085/Z80-based computers with the CP/M-80 operating system

Documentation
73-page users manual

Audience
Business users and hobbyists who want the utilities available on Unix

Listing 1: *A comparison of the Microtools and Unica utility programs made by using the* col *program.*

FUNCTION	MICROTOOLS	UNICA
Concatenate files	cat.com	cat.com
List words in file	deform.com (option)	wx.com
Compare text files	diff.com	sc.com
Search for regular expression in file	grep.com	sr.com
Create file link	ln.com	ln.com
Create pipeline without Microshell	p.com	(not necessary)
Concatenate files horizontally	paste.com	hc.com
Sort lines in memory	sort.com	srt.com
Save temporary file from pipeline	tee.com	tee.com
Find unique lines in file	uniq.com	srt.com (option)
Count words, lines, characters	wc.com	wc.com
Print files in columns	col.com	n/a
Print lines common to two files	com.com	n/a
Encrypt file	crypt.com	n/a
Cut columns from file	cut.com	n/a
Remove editor commands	deform.com	n/a
Echo arguments	echo.com	n/a
Search for string in file	find.com	n/a
Get drive, user for Microshell	get.com	n/a
Merge sorted files	merge.com	n/a
Get item from list for Microshell	next.com	n/a
Print files in pages	pr.com	n/a
Print records on separate lines	rec.com	n/a
Delay processing	sleep.com	n/a
Split file into pieces	spl.com	n/a
Find strings in binary file	str.com	n/a
Compare binary files	n/a	bc.com
Copy file(s)	n/a	cp.com
Create disk allocation map	n/a	dm.com
Compute file CRC	n/a	fid.com
List contents of directory	n/a	ls.com
Change name of file	n/a	mv.com
Set (change) file attributes	n/a	sfa.com
Find spelling errors	n/a	sp.com
Transliterate characters in file	n/a	tr.com
Look up words in dictionary	n/a	wl.com

mand interpreter. The Unica programs, on the other hand, are designed to stand alone, although I have used most of them under Microshell with no serious ill effects. The Microtools programs were written in C (alas, no source code is included). The Unica utilities, by contrast, were written in a structured Z80 assembly language. As a result, the Microtools programs tend to be somewhat larger and slower than their Unica counterparts.

Microcomputer Software Tools

The Microtools packages are distributed by New Generation Systems of Reston, Virginia, the manufacturer of Microshell, and their compatibility with Microshell is one of the main features of the programs. As you might suspect, the company recommends Microshell for use with Microtools.

The Microtools programs, however, can also work with the normal CP/M command interpreter. They contain code to perform input and output redirection and a special, separate utility simulates pipelines. It works by creating a file for submit.com, the batch-processing program supplied with CP/M.

Nevertheless, pipelines are much simpler and cleaner under Microshell. And Microshell provides many other features that these programs can use. The most important is the ability to create "shell files," also known as shell procedures. As the name implies, these files are executable procedures. Their components are whole programs rather than the statements of a programming language.

Two Microtools programs, get.com and next.com, are designed especially for Microshell. They manipulate values in memory that can be used within shell files to pass parameters to programs or to alter program flow.

For example, next.com and another Microtools program, find.com, can be used to create a shell file for erasing some members of a group of related files. This shell file is invoked by typing

eraq <*ambiguous filename*>

after which you're prompted for the files you want to erase.

The source code—a normal text file—is shown in listing 3. The first line uses the -w option of the *find* program

Listing 2: *Using shell files and pipelines. A sample telephone listing (a) is encrypted by the Microtools* crypt *program using the password "justice" (b).* Getphone.sub, *a simple Microshell shell file containing a pipeline, is shown in (c). It reads the encrypted file,* phones.cpt, *using the d(ecrypt) option of the* crypt *program with the second argument of the command line (the password). The output of the* crypt *program is then "piped" (using the | symbol) to the* grep *pattern-matching utility. An invocation of* getphone.sub *under Microshell is shown in (d). The tilde (~) character indicates that the name* johnson *begins with an uppercase "J." (The Microshell prompt is "A0>".)*

(2a)

```
Blair, John                 789-1796
Chase, Samuel               796-1811
Cushing, William            789-1810
Iredell, James              790-1799
Johnson, Thomas             791-1794
Johnson, William            804-1834
Livingston, Brockholst      806-1823
Moore, Alfred               799-1804
Paterson, William           793-1806
Todd, Thomas                807-1826
Washington, Bushrod         798-1829
Wilson, James               789-1798
```

(2b)

```
X2*8;TO#XT`      )4E<FFGK          e-,8)WU8I[]LZ            BJA7BS\_
Z+0/@HGfY7Sfil^iDUYSQWW`
k:'%->Nqk/EXZx  ?@>EYbjd_.7@KA?dbF]jbUn%
OWIDO_qod((8MLQi\:ViloalHPWVTZ\g          q4;-9<X\]Vsn:zztvr '>B  f]jk ))$
elAG@aT|Q[jc\?QTNLRQ_   w.;+?JVX|j@Yfvvtz        JV`]gh_l
~<71XS1U_cQb    HCP@CQUi!%62=RNaVTywI #r{ ~dleYdu )w(2COQuc,J`hy           <DOSZfb`
```

(2c)

```
%break off : ignore attempts to interrupt command
crypt -dp $2 phones.cpt | grep $1
%break on
```

(2d)

```
A0> getphone ~johnson justice
Johnson, Thomas             791-1794
Johnson, William            804-1834

A0>
```

to list all files matching the ambiguous file reference. Find lists one filename on each line. The list is placed in the temporary file eraq.tmp using Microshell's output redirection.

Next.com fetches the name of each program from the list in sequence, erases it from the temporary file, and places it where the Microshell command interpreter can find it. The shell file then prints each filename, asking whether the file should be erased. Depending on the answer, the shell file either erases the file or loops immediately to the next filename. The percent (%) character introduces intrinsic Microshell commands; %print <*string*> outputs a string to the console terminal. The result is a new CP/M utility "program." It works more slowly than a compiled program, but it took only a few minutes to create and debug.

The Microtools programs can also be used independently. For example, I used the program col.com to create the columns in listing 1. Listing 4 shows part of the source file that was fed to col to produce it.

The fact that the programs can work together smoothly is also very important. It makes it possible to create new procedures by constructing shell files. For example, using Microshell and the Microtools utilities, it would be relatively easy to construct a menu-driven software shell, or "front-end", for CP/M.

This front-end processor displays the commands that are available and prompts you in your choice.

Or a simple spelling aid could be created from the Microtools deform.com, sort.com, and uniq.com. Deform (with the -w or word-list option) would break a text file into individual words, one per line. The output of deform

Listing 3: Eraq.sub—*a Microshell shell file to erase multiple files, with a query before each erasure. The shell file (a) uses two Microtools programs,* find.com *and* next.com. *The syntax is* eraq *<ambiguous filename>. An invocation of* eraq.sub *under Microshell is shown in (b).*

(3a)

```
find -w $1 >eraq.tmp
%loop
        next eraq.tmp
        %memstr %1
        %if %1 = done then goto fin
        %print -n "Erase "
        %print -n %1
        %print -n " (y/n)? "
        %getchr %A$ <$T
        %print
        %locase %A$
        %if %A$ NE y then goto %loop
        era $1
        %print -n %1
        %print " erased"
        %goto loop
%fin
        era eraq.tmp
        %exit
```

(3b)

```
A0> eraq byte*.txt
Erase BYTE882.TXT (y/n)? y
BYTE282.TXT erased
Erase BYTE1282.TXT (y/n)? y
BYTE1282.TXT erased
Erase BYTE183.TXT (y/n)? n
Erase BYTE283.TXT (y/n)? n
Erase BYTE883.TXT (y/n)? n

A0>
```

Listing 4: *The source file for listing 1. The file was fed to the Microtools program* col.com *to produce the multicolumn output. Only the first 39 lines of this file are printed.*

```
FUNCTION
MICROTOOLS
UNICA




Concatenate files
cat.com
cat.com
List words in file
deform.com (option)
wx.com
Compare text files
diff.com
sc.com
Search for regular expression in file
grep.com
sr.com
Create file link
ln.com
ln.com
Create pipeline without Microshell
p.com
(not necessary)
Concatenate files horizontally
paste.com
hc.com
Sort lines in memory
sort.com
srt.com
Save temporary file from pipeline
tee.com
tee.com
Find unique lines in file
uniq.com
srt.com (option)
Count words, lines, characters
wc.com
wc.com
```

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Unica: an Update

There has been one major change in the Unica utilities since BYTE last reported on them. The package now includes an outstanding implementation of the Unix utility grep, *which stands for "Globally look for Regular Expressions and Print."*

Grep *is a pattern-matching program. The pattern is a regular expression, composed of normal characters and "metacharacters." The metacharacters generate ambiguously defined patterns that* grep *then searches for. For example, the command*

grep BYTE . *page <*filename*>

will find all lines in a file that contain the word "BYTE" followed by the word "page" and then print them on the console.

An implementation of grep *is included with the Microtools package. It is roughly equivalent to a version of* grep, *originally distributed by the DEC users' group, DECUS. I adapted it for CP/M and placed it in the public domain earlier this year. In fact, the public-domain program is a bit faster than the Microtools version. (The program is available for the taking from a number of remote CP/M systems around the country.)*

The Unica program sr.com *is considerably more sophisticated. It accepts full regular expressions, including conditionals. For example, the command*

sr unix:microtools:unica <*filename*>

will print each line containing the words "Unix," "Microtools," or "Unica." Each subexpression can contain metacharacters and be of arbitrary complexity.

The astonishing thing about sr *is that it is more than twice as fast as either the public-domain or Microtools programs, neither of which permits conditional expressions. The key is a better algorithm—better, as it turns out, than the one used by the Unix utility that matches full regular expressions,* egrep.

A character-transliteration program has also been added to the Unica package. This enables you to make certain substitutions in text files. For example, Unica's tr.com *can be used to map all the characters in a file to either lowercase or uppercase.*

A spelling program, which was almost unusable in the first release of Unica, has been improved. A large dictionary is now available. Unfortunately, the program still doesn't recognize many common variants of root words. And it is much slower than the commercial spelling programs I have seen.

The developers of Unica have taken obvious care to make sure its documentation is properly updated to reflect the current versions of the programs. I wish every software vendor were as conscientious.

would be passed to sort.com in a pipeline. Sort, in turn, would put the lines (words) in alphabetical order. Uniq.com, the last program in the pipeline, would filter out duplicate words. The result: a list of the individual words in the text file, in alphabetical order. The list could then be scanned for any possible misspellings.

Unfortunately, sort.com uses a relatively slow "shell sort" algorithm. It took almost twice as long to sort a file of 1000 words as my homegrown in-memory sorting program, which was created with the same compiler that was used for the Microtools but which utilizes a "quicksort" algorithm. The Unica sorting utility, which was written in a form of assembly language, was faster yet.

Used intelligently, the Microtools programs can be put together to provide some of the facilities of a simple database management system. One of the examples in the well-written manual shows how you can take a text file containing lines of the form—name:address:phone:notation, then cut it up, reformat it, and use it to print mailing labels.

The manual is well organized and clear. But because the idea of connecting programs together is probably a new one for most CP/M users, more examples would be useful. ■

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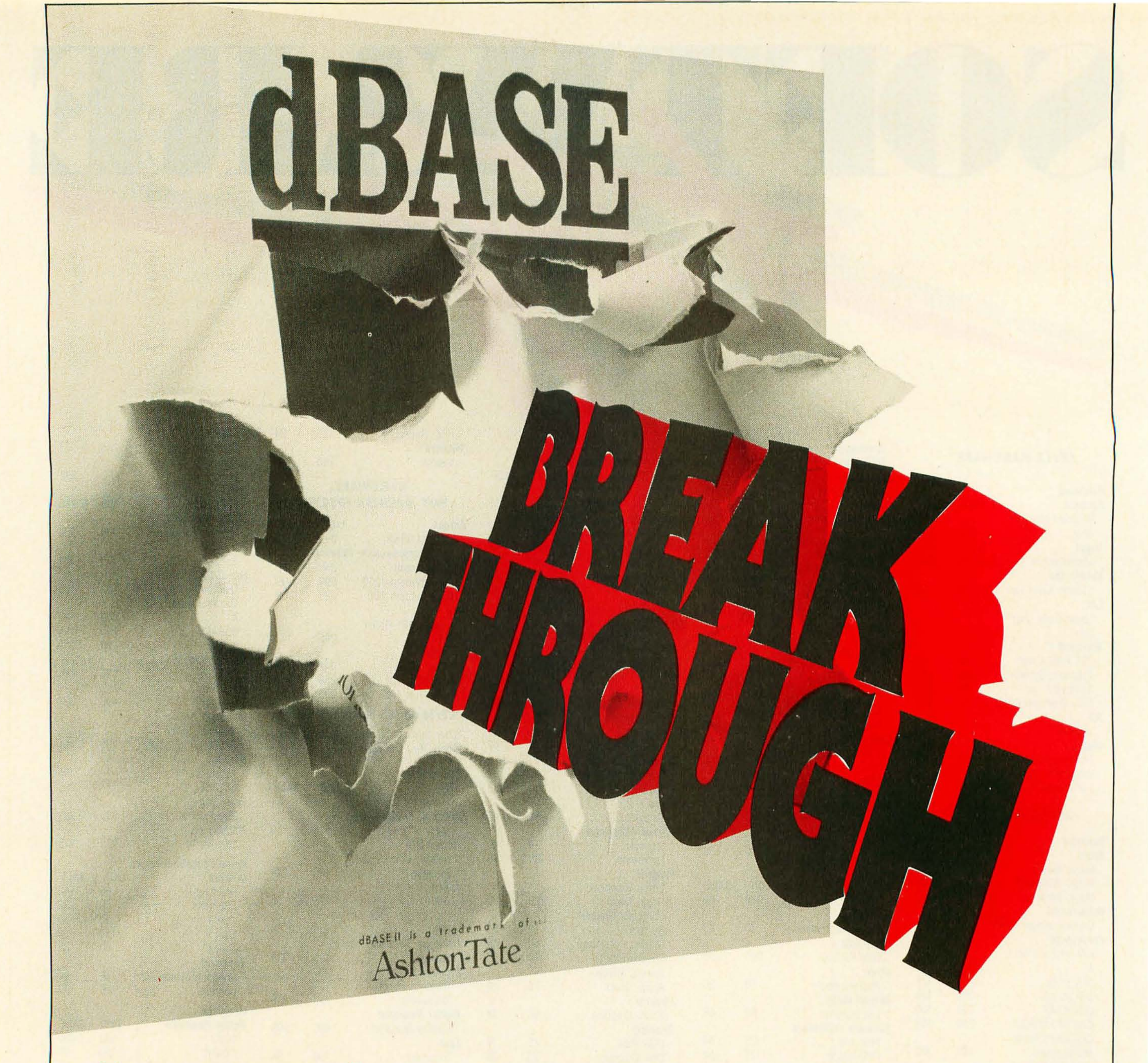
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Mainframe Graphics on a Microcomputer

Display Tektronix-type plots on your microcomputer

by Mahlon Kelly

Did you ever wish you could display complex graphics displays on your microcomputer? Interfacing a microcomputer to a mainframe gives you several advantages. You can double or triple the capabilities of your system. But not all the power of a mainframe is easily available. The high-resolution graphics available on most mainframes require expensive graphics terminals. Except for simple line-plot graphics, most microcomputers don't have the speed or software to handle mainframe graphics.

If you have a microcomputer capable of high-resolution graphics and a smart-terminal program, it's possible to display high-resolution mainframe graphics previously requiring expensive terminals. Just save the mainframe's output as a disk file, then display it on your microcomputer's screen. It's only a matter of converting the output from the mainframe system into a form that your computer will understand.

Tektronix (the oscilloscope company) was the first to produce a high-resolution graphics terminal for large computers. Along with the terminal it produced the software that generated the code necessary to tell the terminal what to do. This set a de facto standard for the industry. Most large computers will produce the code to drive Tektronix terminals. But how can you put the display on the screen of your microcomputer?

The Problem

My research work generates a lot of data that must be interpreted visually. (See "Data Collection with a Microcomputer," March 1983 BYTE, page 295.) The recorded data are sent to a Cyber computer, where they are processed and massaged in various ways. The reduced data are then sent back to my microcomputer for further processing and storage.

The problem is that I can get a good look at the data using various graphics programs, but those programs send output only to a Tektronix terminal or some other terminal that's configured to think it's a Tektronix. (The Retrographics package produced by Digital Engineering for the ADM-3A is a good example.) I was spending too much time commuting between my own LNW-80 microcomputer and our University's Tektronix facility. I needed to send the graphics output to my microcomputer and display it on the screen. Although that seemed difficult at first, it took only a 30-line BASIC program to do the whole job (it took about two weeks of spare time to figure out how). The Tektronix emulation program (see listing 1) has been developed for LNWBASIC on the LNW-80, a microcomputer that is functionally the same as the TRS-80 Model I but that, among other features, has both high-resolution black-and-white and color graphics. The program can easily be translated to other versions of BASIC.

Communications

To understand how the Tektronix terminal works, it's important to understand how computers and terminals communicate over the phone lines. Most terminals respond to ASCII (American National Standard Code for Information Interchange) characters that are transmitted bit by bit. The Tektronix does everything in response to ASCII characters. These characters consist of seven bits of information that can be converted into a set of 127 different decimal-based numbers or an equivalent number of alphanumeric and control characters. The first 31 ASCII characters are control characters. They tell a "normal" terminal what to do. For example, an ASCII 7 tells the terminal to beep or sound a bell, an 8 tells it to do a backspace. Characters 32 through 63 represent various special characters such as *, ?, %, and the numbers 1 through 9. The characters 64 through 95

Listing 1: *The Tektronix emulation program to translate a file of Tektronix graphics control characters to a plot on a microcomputer screen. The program is designed for an LNW-80, but only five lines need to be changed to adapt it to other machines.*

```
10 ' THIS PROGRAM TO PLOT A FILE IN EMULATION OF A TEKTRONIX TERMINAL HAS BEEN DESIGNED TO BE USED ON A LNW-80.
20 ' THE FIVE LINES WITH A REMARK STATEMENT STARTING WITH '***' USE THE LNWBASIC GRAPHICS LANGUAGE. THEY SHOULD BE
30 ' MODIFIED FOR WHATEVER SYSTEM IS TO BE USED. THE PURPOSE OF THOSE LINES SHOULD BE SELF-EXPLANATORY.
40 '
50 '
60 CLEAR 1000
70 MODE 1 ' *** PUTS THE LNW IN HIGH RESOLUTION MODE
80 ' *** IN LINE 40 PCLS CLEARS THE HIGH RESOLUTION SCREEN; CLS CLEARS ALPHANUMERICS.
90 PCLS: CLS: HX=0: HY=0: LX=0: LY=0: OLD=0:CH=0
100 FLAG$="T" ' TELLS THE PROGRAM TO EXPECT TEXT AS A DEFAULT
110 PRINT"WHAT IS THE INPUT FILE NAME? ";
120 LINEINPUT FILE$
130 '
140 ' START THE INPUT.
150 '
160 OPEN"I",1,FILE$ ' OPEN THE INPUT FILE.
170 LINEINPUT #1,A$ ' LINEINPUT BECAUSE THE STRING MAY HAVE UNPRINTABLE CHARACTERS.
180 IF LEN(A$)=0 GOTO 170 ' IF THE INPUT WAS A NULL STRING, GET ANOTHER.
190 '
200 FOR I=1 TO LEN(A$) ' LOOK AT THE WHOLE STRING CHARACTER BY CHARACTER.
210   OLD=CH ' SAVE THE ASCII VALUE OF THE PRECEDING CHARACTER.
220   CH=ASC(MID$(A$,I,1)) ' LET CH = THE ASCII VALUE OF THE CHARACTER POINTED TO.
230   IF CH=29 FLAG$="B" ' IF THE CHARACTER IS A CONTROL GS, SET A FLAG SO THAT THE PEN WILL BE MOVED BUT THE LINE NOT DRAWN.
240   IF CH=12 AND OLD=27 THEN CLS: PCLS ' IF THE CHARACTER PAIR ESC,FF WAS RECEIVED, CLEAR THE GRAPHICS AND ALPHANUMERIC SCREEN.
250   IF CH=31 THEN FLAG$="T" ' IF US WAS RECEIVED, SET THE FLAG TO EXPECT ALPHANUMERIC INPUT.
260   IF CH<32 GOTO 290 ' IF THE CHARACTER IS A CONTROL CHARACTER, JUMP.
270   IF FLAG$="T" PRINT CHR$(CH);:GOTO 290 ' IF IN TEXT MODE, PRINT THE CHARACTER AND GET ANOTHER.
280   GOSUB 350 ' BRANCH TO THE SUBROUTINE THAT DECIDES WHAT THE GRAPHICS CHARACTER DOES.
290 NEXT I ' GO GET ANOTHER CHARACTER.
300 IF EOF(1) THEN CLOSE: STOP ' QUIT IF FILE DONE.
310 GOTO 170 ' GO GET ANOTHER STRING.
320 '
330 ' FOLLOWING IS A SUBROUTINE TO DECIDE WHAT TO DO WITH THE GRAPHICS CHARACTERS.
340 '
350 IF CH>31 AND CH<64 AND OLD>95 AND OLD<128 THEN HX=CH: OLD=CH: RETURN ' IF THE CHARACTER IS A 'HI'
360 '  AND THE PREVIOUS WAS A 'LO Y', THEN THE CHARACTER IS A 'HI X' (SEE TEXT).
370 IF CH>31 AND CH<64 THEN HY=CH: OLD=CH: RETURN ' IF THE CHARACTER HAS A VALUE BETWEEN 31 AND 64,
380 '  THEN IT'S A 'HI Y'; IT ISN'T A 'HI X' BECAUSE IT PASSED THE TEST OF THE PREVIOUS STATEMENT.
390 IF CH>95 AND CH<128 THEN LY=CH: OLD=CH: RETURN  ' IF THE CHARACTER VALUE IS BETWEEN 95 AND 128 THEN IT'S A 'LO Y'.
400 IF CH>63 AND CH<96 THEN LX=CH: OLD=CH: GOSUB 440: RETURN ' IF THE VALUE IS BETWEEN 63 AND 96 THEN IT'S A 'LO X'; DO A PLOT.
410 '
420 ' SUBROUTINE FOR ACTUAL PLOTTING; CHANGE LINES 480 AND 490 FOR APPROPRIATE SCREEN RESOLUTION.  SEE TEXT.
430 '
440 X=.47*((HX-32)*32+LX-64) ' *** CONVERT HX AND LX TO THE VALUE OF X TO BE PLOTTED.  SEE TEXT.
450 Y=192-.25*((HY-32)*32+LY-96) ' *** CONVERT HY AND LY TO THE VALUE OF Y TO BE PLOTTED.  SEE TEXT
460 DRAW"XFLAG$,MX,Y" ' *** IF FLAG$="B" MOVE TO X AND Y BUT DON'T DRAW. IF FLAG$="A" THEN MOVE AND DRAW.
470 FLAG$="A" ' SET IT SO THE NEXT LINE WILL BE DRAWN.
480 RETURN
```

represent uppercase letters and a few symbols like @. From 96 through 127, the input represents lowercase letters and a few other symbols. While most terminals will respond to the ASCII codes—that is, they will print a B when the code 66 is sent—the Tektronix can either act like a normal terminal or interpret the characters to draw straight lines.

That's all the Tektronix terminal can do. In terms of graphics, all it can do is draw straight lines. Think of it as a plotter with a point on the screen that can move from one point (specified as an *x,y* coordinate) to another point. It can move the pen in a down or lifted position; that is, it can move it and draw a line or move it without drawing a line. Of course, very short, straight lines when combined end to end can look like a curve. Everything on a Tektronix screen is the product of a series of straight lines, written with the pen either in the up or down position.

How can this help you use a microcomputer to plot a graph intended for a Tektronix? First, you need to receive the characters intended for the graphics terminal. If you have a good smart-terminal package and you can access a mainframe, tell the mainframe that you are using a Tektronix terminal (you would tell the same lie if you had a modified ADM-3), set it

Listing 2: *Part of an output file giving directions for a graphics plot on a Tektronix terminal. Although it may look like garbage, it produces very precise instructions and plots.*

```
A%cChF1HnKpMPoRmUjWgZd]`_$|/BwDrGmIhLbN#|QwSrVmXi[e]a0@"^C<ExHvJtMsOrRTWsYu\x^|1
AC#dFkIrKyN$aPhSpUwX^Z%e]j_o2BrDtGJLsOqQoT1VjYg[d^`3@$>CxEsHoJjMfFcR#U|WyZv\t_r4
ApDnFmIkKNPS1VmXo[s]x5@<B^E$bGhJpLx0%`QfTiVnYr\t^v6ACFuHtKqMoPmRjUgWdZa]$>_z7BvD
rGoIkLiNfQdSbV`X#^[|]<8@zCyEHJMO<R|T>W^Y\$a^c9ACdFIKNePfSgUiXjZ]_i:BgDeGcIaL`0#Q
^T>V<Yy[w^"r$DFIKNPQSUVX[]r%@BBEGHJMOQTVY[\^r&ACFGIKMMPRUXYZ]__r'BDGIKLNQQSVY[]]
r(@BDEHJMOPRUVWY\^r)ABDFHIKNPSTUXZZ]_r*BEFGJLMNQTVYY[^_r+ACEHJKMPQ:UEUWtU$1ACDFI
KNOQSVVXZ]r-@BBEGHJMORTTVYZ\^r.ACFHKLNPRUWXZ]__r/BDFIKLNQQSVY[]^r0@BCEHJMOORTUWZ
\^r1ACFHIKNPRTVXZZ]_r2BEFGJLLNQTVXY[^^r3@CFHJJMOQRUWZ\]_r4BCDFIKNOQSUVX[]r5@ABEG
GJLORSTVYZ[^r6ACFFHKLNPRUWXZ]^_r7BDGIJLNPQSVX[\^r8@CCEGJMOORTUWZ\^r9AACFGIKNPSUX
YZ]_r:BDEGJLLOQSVXY[^^i;MGjF1FnGM1NjNiMoNqNrMNqMNrNMqMvNwMGxF<F|GM<NxNwM>NMG#`Fb
FcGMbN`N"M#eN"rCr;^$o^o;CeGgFiFjGHiIgIiIjKMiNgNeM1NnNoMNnMNoNMnMsNtMGuFxFyGMxNuN
tMzN<MG>FF%`GM$N>N<M%aN$oCo:^&k^k;CgGfFcFbGMcNfNgLfKbLhNkN1MNkMN1NMkMpNqMGrFuFvG
MuNrNqMwNxMGyF|F>GM|NyNxM^NkCk:^(h^h;C'M(`NcNdMGcF`F'H(`IdIeNh
```

up to send the output for a plot, and then save the output to a disk file. You may have to change the translation tables in your smart-terminal program so that the control characters aren't changed, but that should be straightforward. You now have a file that was intended to produce a plot. It will look like garbage (listing 2 shows part of such a file), but it really does have meaning.

How does the Tektronix interpret the characters it receives to draw a line? This is the hard part. First, remember that it only draws a straight line from a point where the last line left off to a new point specified by X and Y coordinates with the pen either lifted or down. (At the start of a program the terminal assumes the pen to be at coordinates 0,0.) The terminal has to receive 4 bytes (actually four 7-bit characters between 0 and 127 decimal) to know where to end the line. There's not enough information in a single byte to specify an X or Y coordinate, so each coordinate uses 2 bytes. The bytes are called Hi X (HX) and Lo X (LX) and Hi Y (HY) and Lo Y (LY); Hi specifies the larger part of the number for the coordinate and Lo specifies the smaller. HY and LY are converted to a value corresponding to a Y coordinate and HX and LX do the same for X. The numbers are stored, and as soon as an LX is received, the terminal responds by drawing a line. When it receives HX, HY, or LY, it simply stores them while waiting for the LX.

How does the terminal know whether the character it receives is an HX, an LY, or whatever? Remember that each character that's received has an associated numerical value. If the value is between 64 and 95, it's an LX. If it's between 96 and 127, it's an LY. If it's between 32 and 63, it can be either an HX or an HY. If the Hi number is *immediately* preceded by an LY, then it is an HX; otherwise it's an HY. So the terminal stores LX and LY according to the value of the incoming byte, and it stores HX or HY according to the value of the byte and whether the previous byte was an LY.

You might think that the computer would send 4 bytes for every line to be plotted, but it doesn't. Because the line is often short, HX and HY change infrequently, and often only X or Y changes. To wait for 4 bytes

to be sent when 1, 2, and 3 would do is very inefficient. Of course, if HY, LY, HX, and LX are sent in that order, all will be stored, and that's OK with the terminal. However, if only the Lo X value must be changed, then only an LX is sent (remember that a line is drawn whenever an LX is received). If LY and LX must be changed, two bytes will be sent (LY and LX). If HX and LX must be changed, then LY, HX, and LX will be sent in that order. The LY tells the terminal that the Hi byte is an HX and not an HY. If HY and LX must be changed, then HY and LX are sent. To change all 4 bytes, all 4 bytes are sent.

Once the terminal has 4 bytes in memory and it receives an LX, how does it know where to draw the line? First, the line starts at the end of the last line. That's simple. The end of the *new* line is specified by HY, LY, HX, and LX as they are stored in memory. The coordinates are calculated as follows:

$$X=(HX-32)*32+LX-64$$

and

$$Y=(HY-32)*32+LY-96.$$

Those equations are for a Tektronix terminal, and that terminal has a maximum value for X of 1024 and a maximum for Y of 780. You must multiply X and Y by appropriate factors if your screen has a lower resolution. For example, my LNW has a maximum resolution for X of 492, and I must multiply X by 492/1024 to have all of the plot on the screen. A few computers expect $Y=0$ to be in the upper left-hand corner. In that case, subtraction is needed, as for my LNW. For the LNW, $Y=192-(192/780*((HY-32)*32+LY-96))$ and $X=492/1024*((HX-32)*32+LX-64)$ will produce a plot with $X=0$ and $Y=0$ in the lower left-hand corner.

The terminal also responds to control characters. The two most important characters have ASCII values of 31 and 29. Remember that the terminal has two modes of operation: graphics and alphanumerics. If it's in graphics mode and receives a 31, the terminal sets itself to alphanumeric mode and will print the string "rose" not as the flower but the word. If it receives 31 while in alphanumeric mode, it will do nothing. If it receives a 29 while in alphanumeric mode, it will go into graphics mode. The first coordinate it receives (as HY, LY, HX, LX) will make it move its pen, but with the pen raised, thus going to a new line origin. The second set of coordinates will make it draw a line. Each set of coordinates after that will produce another line. If it receives a 29 in graphics mode, the pen will be lifted and go to the next set of coordinates to be received. If the received coordinates are exactly the same as were previously received, then a single point will be drawn. Using this scheme any shape can be drawn, and the pen can be moved around to plot anywhere on the screen (if a 29 is sent first).

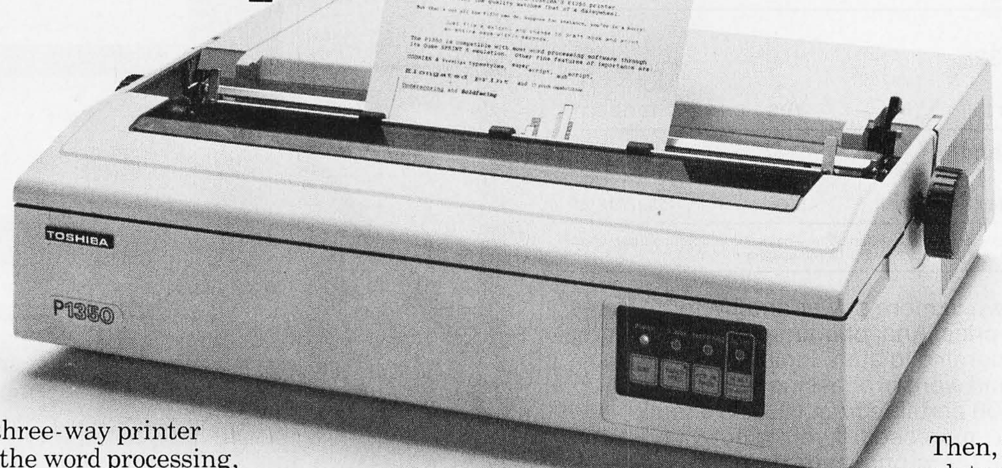
There are other control codes. The most important is a sequence of two bytes: 27 (escape) and then 12. This tells the terminal to erase the screen, both the graphics and alphanumeric modes. The code 26 erases the alphanumerics but not the plot.

It should be possible for some enterprising programmer who understands mainframe graphics to write a smart-terminal program for most microcomputers that would eliminate the step of storing the graphics file and then displaying it with a BASIC program. The microcomputer, in other words, would act just like a Tektronix terminal with the plot appearing as it came in over the phone. The advantages would be that the plot could be stored on disk and sent to a point-addressable printer. Writing such a program is beyond my ability and ambition.

Tektronix has defined the most simple and efficient way to transfer graphics output. If the procedure is understood by microcomputer programmers, we will soon have smart terminals that have the ability to receive not only alphanumeric output but graphics displays as well.■

Mahlon Kelly (268 Turkey Ridge Rd., Charlottesville, VA 22901) is associate professor of Environmental Sciences at the University of Virginia.

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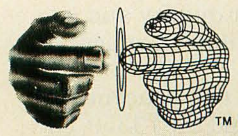
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Talker

A routine developed for Radio Shack's TRS-80 and Votrax's Type-'N-Talk makes writing talking programs easier

by Heyward S. Williams

Writing a talking program is simple if you can use the PRINT and INPUT statements to automatically transfer information to the speech synthesizer. Talker is a keyboard and video-intercept routine that performs this function for the TRS-80 and the Votrax Type-'N-Talk voice synthesizer. Although vocal programs are useful in many areas, I wrote this utility routine specifically because I became involved with writing programs for the visually handicapped.

I began work on Talker in 1981 when my wife, Suzanne, lost her sight from a combination of neurovascular rubeosis and retinopathy.

During her rehabilitation, we searched for better ways to handle everyday problems that confront a blind person, such as writing letters and finding addresses or recipes. There was little hope that Suzanne could return to her profession in retailing if she could not access the data she needed to perform her job.

To help solve these problems, I began an investigation of voice synthesizers that would enable Suzanne to use our TRS-80. The only synthesizers available at the time had specific vocabularies, which limited them in our application. One unit, the Sweet Talker from Micromint Inc., provided its host computer with a software-resident text-to-speech capability and seemed to be the best solution. Unfortunately, it ran only on an Apple II, and because I had already spent several lifetimes learning the idiosyncrasies of my TRS-80, I was hesitant to change machines. Then Votrax Inc. introduced the Type-'N-Talk. This unit uses an RS-232C interface and includes a microprocessor programmed to internally execute a text-to-speech algorithm that simplifies the job of writing voice-output programs. Although it is somewhat primitive and occasionally amuses us with original pronunciations, it is reasonably priced and adequately fulfills our requirements.

The first program I wrote for the Type-'N-Talk was a typing review and exercise routine that served to overcome Suzanne's mild case of "computerphobia" and familiarize me with the requirements of the synthesizer. Written in machine language, the program is relatively simple.

Next came a more ambitious project: I wrote a simple word-processing program or, as we call it, the Friendly Letter Writer. Although this program is also written in machine language, by the time I had it almost finished I was convinced that I needed to find a way to write future programs in BASIC if I hoped to ever get them done.

Sending text to the synthesizer from BASIC is not difficult, but the task does require extra lines. This constraint was undesirable because I wanted to use commercially available programs with little or no modification. Back I went to my editor-assembler to write a machine-language program that would make programming spoken text easier. The result, presented here, is called Talker.

Features

Talker has many useful features:

- It is transparent to the keyboard and video routines so that normal BASIC commands such as INKEY$ and PRINT can transfer information to the synthesizer as well as execute their normal functions
- It is written in machine language to minimize processing delay
- It repeats each key as it is pressed
- It reads whatever is written to the video display
- A character immediately sent to the video display from the keyboard is not repeated

•It pronounces punctuation marks and, if they are returned from the keyboard, the control codes (the Type-'N-Talk unit alone does not pronounce punctuation or control codes)
•It skips redundant spaces, which are often used to position titles on the display but which would result in excessive delays in the spoken text
•The text transmitted to the Type-'N-Talk is spoken if a carriage-return character or two consecutive spaces are encountered
•The spoken response can be turned off and on from the keyboard or by sending special characters to the display
•Talker can be put into a mode in which it ignores some punctuation by sending special characters to the display
•It automatically relocates itself to the end of high memory, resets the high-memory pointer, changes the keyboard and video-driver vectors, and jumps to BASIC or returns to the disk operating system (DOS)
•The program operates without modification on Model I or Model III computers
•It occupies less than ½K byte of memory
•It is compatible with Level II BASIC, TRSDOS, and NEWDOS

Talker operates best with a disk system because of the ease with which some programs can be implemented, but a disk system is not necessary.

In one mode, Talker ignores some punctuation by sending special characters to the display.

Hardware and Setup

To run Talker, you'll need an RS-232C interface board to enable the Type-'N-Talk unit to receive information from the computer. These boards are available from Radio Shack (part numbers 26-1145 and AXX0511 for Models I and III, respectively). You must modify the RS-232C connection to work with the Votrax unit, however, because this application requires only the RECEIVE-ONLY mode (the Votrax unit provides more modes than are necessary). To implement the RECEIVE-ONLY mode, the Ground Return lines (pins 1 and 7) and the Ready to Transmit (RTS, pin 5) lines must connect to the TRS-80. The next step involves resolution of the standard problem associated with RS-232C transmissions: the proper connection of the Transmit Data and Receive Data lines. It seems that every piece of equipment designed considers itself the controller, asserting that pin 2 on its connector is the Transmit Data line and expecting that everything else will dutifully receive data on this line. The Type-'N-Talk is no exception to this, and to make it work properly, pin 2 on the TRS-80 connector must go to pin 3 on the synthesizer. (In theory, you could put the COMM/TERM switch on the Model I's RS-232C board in the COMM position to solve this problem; the Model III doesn't have this switch.) Finally, pins 4, 8, and 20 on the Type-'N-Talk must connect for proper operation. I used two RS-232C connectors (Radio Shack 276-1547 male and 276-1548 female) separated by ¾-inch spacers (from Radio Shack's 64-3024 assortment) and held together by 1-inch 4-40 machine screws to make a jumper. Figure 1 shows the necessary connections. The female connector plugs into the RS-232C cable, and the male connector plugs into the Votrax unit. For a Model I system, the COMM/TERM switch must be in the TERM position. The sense switch settings on the Model I RS-232C board are not important because the bps (bits-per-second) rate is set in the software.

The Type-'N-Talk can retransmit data it receives to other units (modems and printers) on the same RS-232C line. I disabled this feature to improve throughput because my printer has a parallel interface. I have not investigated whether this program can run both the Votrax unit and a printer on the same interface.

Set the Baud Rate switches on the back of the Type-'N-Talk for 9600 bps (switches 1 through 7 up, switch 8 down), the rate selected in the software.

You'll need an external speaker and, to connect it to the synthesizer,

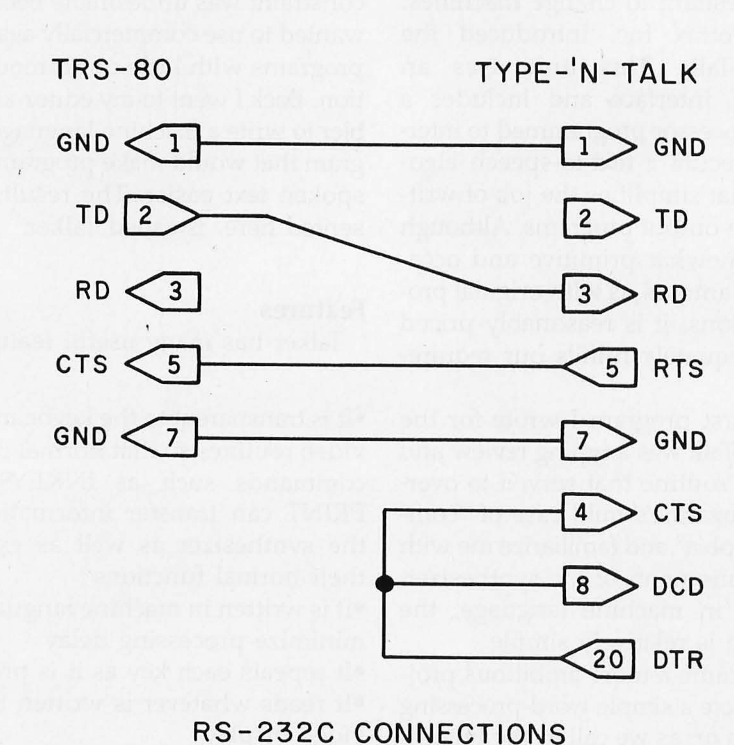


Figure 1: *A schematic illustrating the RS-232C connections between a TRS-80 computer and a Type-'N-Talk voice synthesizer.*

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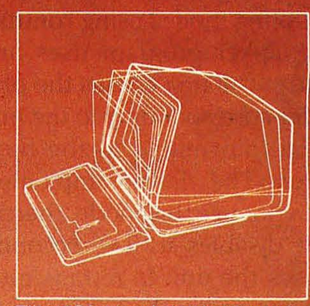
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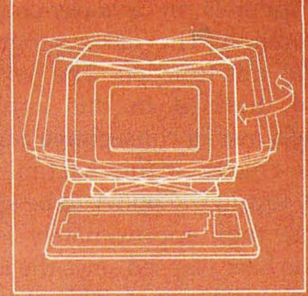
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Commands and Operation

You can select four Type-'N-Talk operating modes using control codes. The Talker program uses only one mode. The first causes the phoneme codes corresponding to the input text to be transmitted to the host computer. The Talker implementation does not use this mode, therefore the unit disables it. The second mode causes the unit to retransmit the input text on the RS-232C lines to other peripherals in a daisy-chain configuration. The Talker program disables this function. The next mode, also disabled in this application, spells out all consecutive capital letters. Finally, an internal timer causes any text in the buffer to be spoken if more than approximately four seconds have elapsed since the last character was received. This mode is left operational and is used by Talker.

The most important command that the Votrax unit recognizes is the carriage return (hexadecimal 0D, decimal 13). This command causes any text in the buffer to be spoken and is used extensively by the Talker program.

Within the Type-'N-Talk, an internal 750-character buffer stores incoming text. If it is filled before a carriage return is received, the unit stops accepting transmissions and speaks the text. Recognizable characters are limited to uppercase and lowercase characters and numbers. The unit ignores punctuation and control characters; they must be translated by the program.

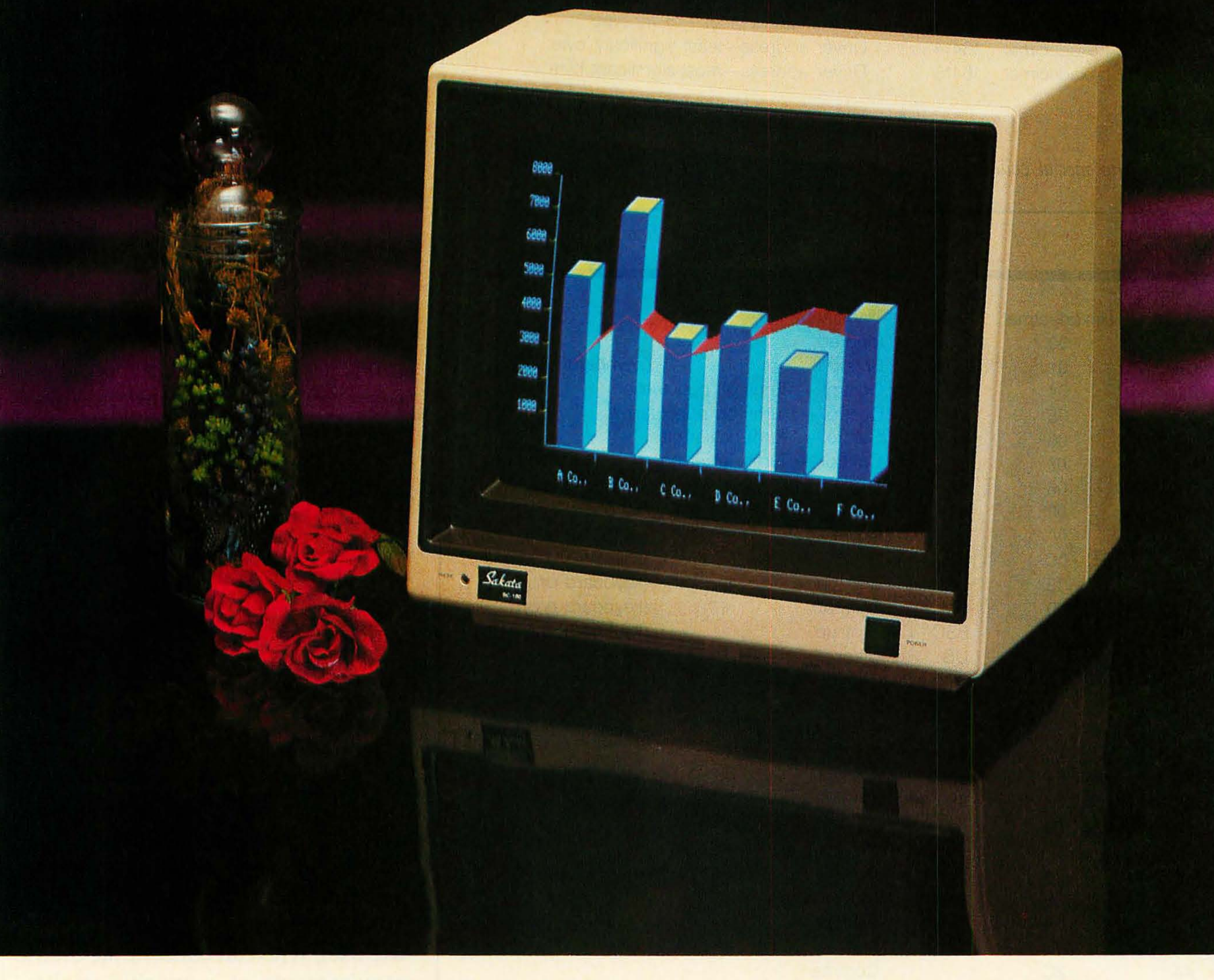
Talker does not use the phonetic programming modes of the Type-'N-Talk unit; the text-to-speech algorithm is adequate.

The Driver Vectors

The key to program operation lies in the use of vector addressing to locate the keyboard and video-display driver routines in the TRS-80. A block of RAM (random-access read/write memory) is set aside for information about the keyboard and the display. The RAM locations in the block are initialized when the computer is first turned on or reset; the locations contain the information listed in table 1 on page 452.

The RAM locations allow execution of appropriate subroutines. For example, if a PRINT statement is encountered, the BASIC interpreter calls a subroutine that goes to hexadecimal RAM 401E through 401F (decimal 16414 through 16415) to find the address of the driver that will print the specified character on the display and then jumps to that address. It isn't difficult, therefore, to insert the Talker routine in series with the display driver. The original address is taken from the vector location hexadecimal 401E through 401F and saved as the exit address from Talker. The address of Talker is written in its place. When the display driver is called, the program goes first to the Talker routine, then on to the original driver, and finally back to the host program.

Essentially the same thing happens to the keyboard driver except that the


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Location		Description
4015 hexadecimal	16405	Start of keyboard block—driver type
4016 hexadecimal	16406	Driver address—least significant byte
4017 hexadecimal	16407	Driver address—most significant byte
401D hexadecimal	16413	Start of video block—driver type
401E hexadecimal	16414	Driver address—least significant byte
401F hexadecimal	16415	Driver address—most significant byte

Table 1: *The special codes used to control Talker.*

Decimal	Hexadecimal	ASCII	Translated	
00	00	NULL	Ignored	
01	01	SOH	Break	(keyboard only)
04	04	EOT	Control — Turns off punctuation	
05	05	ENQ	Control — Turns on punctuation	
06	06	ACK	Control — Turns Talker off	
07	07	BEL	Control — Turns Talker on	
08	08	BS	Back	(keyboard only)
09	09	HT	Tab	(keyboard only)
10	0A	LF	Down	(keyboard only)
10	0D	CR	Sends carriage return	
24	18	CAN	Shift back	(keyboard only)
25	19	EM	Shift tab	(keyboard only)
27	1B	ESC	Shift up	(keyboard only)
31	1F	US	Clear	(keyboard only)
32	20	SP	Space	(keyboard only)
33	21	!	Exclamation *	
34	22	"	Quote *	
35	23	#	Number	
36	24	$	Dollar	
37	25	%	Percent	
38	26	&	And	
39	27	'	Apostrophy *	
40	28	(	Paran *	
41	29	)	Close paran *	
42	2A	*	Asterisk *	
43	2B	+	Plus	
44	2C	,	Comma *	
45	2D	–	Minus *	(could be dash)
46	2E	.	Point *	(could be period)
47	2F	/	Slash	
48–57	30–39	0–9	Numbers 1 through 9	
58	3A	:	Colon *	
59	3B	;	Semicolon *	
60	3C	<	Less	
61	3D	=	Equals	
62	3E	>	Greater	
63	3F	?	Question *	
64	40	@	At	
65–90	41–5A	A–Z	Letters A through Z	
91	5B		Up *	
92–95	5C–5F		Ignored	
96	60		Control — Turns Talker off (keyboard)	
97–122	61–7A	a–z	Letters a through z	
123–255	7B–FF		Ignored	

* Not spoken if punctuation off

Table 2: *The characters recognized as valid by Talker and their translations. The spelling errors correct pronunciation problems in the voice synthesizer.*

Talker program must intercept the character after it has been generated by the keyboard. Here the Talker program calls the original keyboard driver. After the original keyboard driver has done its job, it returns to the Talker program, which performs its magic and returns to the host program.

Philosophy

Because the program was written for a visually impaired person who was not computer-oriented, simplicity and ease of use were important.

Each key on the keyboard, including all the punctuation marks and control codes (see table 2), is spoken as it is pressed. Although more characters can be displayed on the video screen, only those that correspond to the keyboard are spoken, keeping the number of characters to a minimum. To make the visualization process even easier and to increase the speed at which the text can be read, the operator has the option of preventing some punctuation marks from being spoken when they are displayed on the video screen. Imagine (comma), if you can (comma), how advantageous this can be (exclamation)!

Ideally, turning the computer on should automatically load the program to eliminate any technical decisions that might be confusing to a blind operator. The computer operating system becomes transparent to the user, who can concentrate on the requirements of a specific applications program. Incidentally, I have found that this philosophy is equally valuable when writing programs for people who are not handicapped by anything but their own fear of computers. In fact, I often use it on programs written for my own use, simply because I am too lazy to type in all the required statements to get the program to run time after time.

If the program is not being used by a visually handicapped person, the character set can be expanded, and normal modes of loading and executing programs can be used.

Loading

I was able to implement the automatic loading system easily using a

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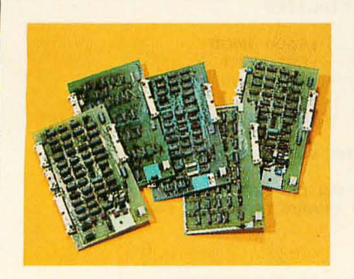
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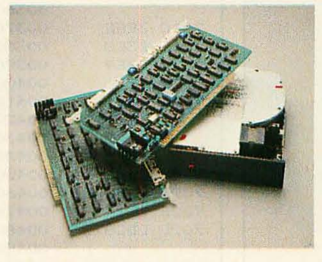
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disk system and NEWDOS/80 version 2.0. I disabled the date and time prompts using the NEWDOS SYSTEM command and set the AUTO command to run TALKER/CMD. When the computer is turned on, the program relocates itself, performs some housekeeping to set up the interfaces, exits to BASIC, and starts executing a menu program. This procedure works equally well with Model I and Model III TRS-80 computers.

When I decided to write this article, I realized that I would have to try the program with TRSDOS. I found my old Model I TRSDOS 2.3 disk and discovered that I could use the AUTO command, which loads and executes the Talker program. However, when the relocation routine exits to DOS, the operator must type BASIC, answer the NUMBER OF FILES? and MEMORY SIZE? questions, and then select a specific program to run. But don't despair; keep reading and you will find a version of the Talker program that simplifies this operation.

The same result can be accomplished with TRSDOS on the Model III; however, the DATE and TIME questions must be answered before

Text continued on page 466

Listing 1: *The Talker program and symbol table.*

```
                ;RELOCATABLE TALKING INTERCEPT PROGRAM  (TALKER)
                ;
7000                    ORG     7000H
                ;
7000 20                 DEFM    ' 14 APRIL 1983 '
                ;
                ; ROUTINE TO RELOCATE PROGRAM TO HIGH MEMORY
                ;
                ; ONCE THE PROGRAM HAS BEEN RELOCATED, THIS PART OF THE
                ;     PROGRAM IS DISCARDED
                ;
4049            HIMEM1  EQU     4049H   ;MODEL I END OF MEM ADDR
4411            HIMEM3  EQU     4411H   ;MODEL III END OF MEM ADDR
4016            KBDADR  EQU     4016H   ;KEYBOARD DRIVER VECTOR LOCATION
401E            CRTADR  EQU     401EH   ;DISPLAY DRIVER VECTOR LOCATION
                ;
                ; FIRST THE DISPLAY & KEYBOARD DRIVER ADDRESSES ARE
                ;    TRANSFERED FROM THE VECTOR LOCATIONS INTO THE PROGRAM
                ;
7010 2A1E40     START   LD      HL,(CRTADR)     ;DISPLAY DRIVER VECTOR
7013 225972             LD      (CRTRET),HL
                ;
7016 2A1640             LD      HL,(KBDADR)     ;KEYBOARD DRIVER VECTOR
7019 220172             LD      (KBDRET),HL
                ;
                ; NEXT THE RS-232 PORT IS INITIALIZED
                ;
701C 3EEE               LD      A,0EEH          ;9600 BAUD
701E D3E8               OUT     (0E8H),A        ;RST UART
7020 D3E9               OUT     (0E9H),A        ;SET BAUD RATE
7022 3E6C               LD      A,6CH
7024 D3EA               OUT     (0EAH),A        ;SET CONTROL REGISTER
                ;
                ;THE RETRANSMISSION MODE OF THE VOTRAX UNIT IS TURNED OFF
                ;
7026 3E1B               LD      A,1BH   ;TO TURN OFF ECHO MODE
7028 CDC872             CALL    SEND    ;SEND CHARACTERS 1BH 14H
702B 3E14               LD      A,14H
702D CDC872             CALL    SEND
                ;
                ; NOW THE LENGTH OF THE PROGRAM IS DETERMINED
                ;     AND HIGH MEMORY IS CHANGED
                ;
7030 2A4940             LD      HL,(HIMEM1)     ;MODEL I END OF MEM ADDR
7033 3A5000             LD      A,(0050H)       ;CHECK MOD I OR MOD III
7036 FE0D               CP      0DH
7038 2803               JR      Z,SET1          ;JUMP IF MODEL I
703A 2A1144             LD      HL,(HIMEM3)     ;MODEL III END OF MEM ADDR
                ;
703D 01B401     SET1    LD      BC,LAST-BEGIN ;LENGTH OF PROGRAM
7040 B7                 OR      A               ;CLEAR CARRY
7041 ED42               SBC     HL,BC
                ;
7043 FE0D               CP      0DH             ;CHECK MODEL I OR MODEL III
7045 2805               JR      Z,SET2          ;JUMP IF MODEL I
7047 221144             LD      (HIMEM3),HL     ;SET MODEL III HIGH MEM
704A 1803               JR      SET3
704C 224940     SET2    LD      (HIMEM1),HL     ;SET MODEL I HIGH MEM
704F 23         SET3    INC     HL      ;POINT HL @ NEW START ADDR OF PROG
7050 E5                 PUSH    HL      ;SAVE NEW START ADDRESS
                ;
                ; DETERMINE NUMBER OF BYTES BETWEEN THE PRESENT LOCATION
                ;    OF THE PROGRAM & THE ADDRESS AT WHICH IT WILL BE WHEN
                ;    IT IS RELOCATED
                ;
7051 110072             LD      DE,BEGIN ;PRESENT ADDR 1ST BYTE OF PROG
7054 AF                 XOR     A
```

Listing 1 continued on page 456

Listing 1 continued:

```
7055 ED52            SBC   HL,DE       ;NEW BEGINNING - PRES BEGINNING
7057 EB              EX    DE,HL       ;DIFFERENCE INTO REGISTER DE
                 ;
                 ; NEXT THE VARIOUS ABSOLUTE ADDRESSES IN THE PROGRAM ARE
                 ;     ADJUSTED TO REFLECT THE NEW LOCATION
                 ;
7058 218372          LD    HL,FIND
705B 19              ADD   HL,DE
705C 221A72          LD    (F11+1),HL
                 ;
705F 215B72          LD    HL,DISTLK
7062 19              ADD   HL,DE
7063 225472          LD    (CONT+2),HL
                 ;
7066 21E372          LD    HL,LTRFLG
7069 19              ADD   HL,DE
706A 224872          LD    (CONS+1),HL
                 ;
706D 21DF72          LD    HL,TOGG
7070 19              ADD   HL,DE
7071 220772          LD    (S1+1),HL
7074 223072          LD    (S2+1),HL
                 ;
7077 21C872          LD    HL,SEND
707A 19              ADD   HL,DE
707B 22B472          LD    (T1+1),HL
                 ;
707E 21C672          LD    HL,CR
7081 19              ADD   HL,DE
7082 222272          LD    (T2+1),HL
                 ;
7085 21C272          LD    HL,SPACE
7088 19              ADD   HL,DE
7089 22AF72          LD    (SPKWD-2),HL
                 ; THE NEW KEYBOARD & DISPLAY VECTORS ARE THEN CALCULATED
                 ;      AND PUT IN THE NORMAL VECTOR LOCATIONS
                 ;
708C 212D72          LD    HL,TCRT             ;DISPLAY ROUTINE
708F 19              ADD   HL,DE
7090 221E40          LD    (CRTADR),HL
                 ;
7093 210072          LD    HL,ECHO             ;KEYBOARD ROUTINE
7096 19              ADD   HL,DE
7097 221640          LD    (KBDADR),HL
                 ;
                 ; FINALLY THE PROGRAM IS TRANSFERED TO THE NEW LOCATION
                 ;
709A D1              POP   DE                  ;NEW BEGINNING ADDRESS
709B 210072          LD    HL,BEGIN            ;OLD BEGINNING ADDRESS
709E EDB0            LDIR              ;REG BC STILL HAS LENGTH OF PROG
                 ;
                 ; NOW RETURN TO DOS OR JUMP TO BASIC & RUN A PROGRAM
                 ;
70A0 21A670          LD    HL,BASIC
70A3 C30544          JP    4405H               ;NEWDOS DOS COMMAND MODE
                 ;
70A6 42          BASIC DEFM  'BASIC 3V,RUN"DATE"'
70B8 0D              DEFB  0DH
                 ;TRSDOS CHAINING ROUTINE
                 ;
                 ;THE NEW KEYBOARD & DISPLAY VECTORS ARE CALCULATED
                 ;    AND PUT IN THE NORMAL VECTOR LOCATIONS
                 ;
70B9 212D72          LD    HL,TCRT             ;DISPLAY ROUTINE
70BC 19              ADD   HL,DE
70BD 221E40          LD    (CRTADR),HL
                 ;
70C0 210072          LD    HL,ECHO                  ;KEYBOARD ROUTINE
70C3 19              ADD   HL,DE
70C4 22F870          LD    (TKBDR),HL          ;SAVE FOR FUTURE USE
                 ;
                 ; FINALLY THE PROGRAM IS TRANSFERED TO THE NEW LOCATION
                 ;
70C7 D1              POP   DE                  ;NEW BEGINNING ADDRESS
70CB 210072          LD    HL,BEGIN            ;OLD BEGINNING ADDRESS
70CB EDB0            LDIR              ;REG BC STILL HAS LENGTH OF PROG
                 ;
                 ;NOW RETURN TO DOS & CHAIN TO BASIC
                 ;
70CD 21DC70          LD    HL,CHAIN            ;SET KBD VECTOR FOR CHAIN
70D0 221640          LD    (KBDADR),HL
                 ;
70D3 21FA70          LD    HL,COMD             ;COMMAND STRING
70D6 22F670          LD    (COMREG),HL         ;SAVE HL
70D9 C32D40          JP    402DH               ;JUMP TO TRSDOS
                 ;
70DC 2AF670      CHAIN LD    HL,(COMREG)       ;COMMAND STRING ADDR
70DF 4E              LD    C,(HL)              ;COMMAND CHARACTER
70E0 23              INC   HL                  ;POINT TO NEXT CHARACTER
70E1 22F670          LD    (COMREG),HL         ;SAVE NEXT STRING ADDR
70E4 110C71          LD    DE,ECOMD+1          ;END OF COMMAND STRING
70E7 7C              LD    A,H                 ;TEST FOR END OF COMM STR
70E8 92              SUB   D
70E9 2002            JR    NZ,CH1
70EB 7D              LD    A,L
70EC 93              SUB   E
70ED 79          CH1 LD    A,C
70EE C0              RET   NZ                  ;RETURN IF NOT END
```

Listing 1 continued on page 458

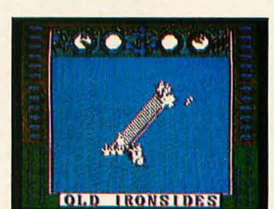
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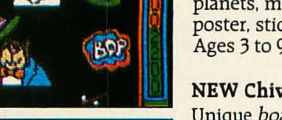
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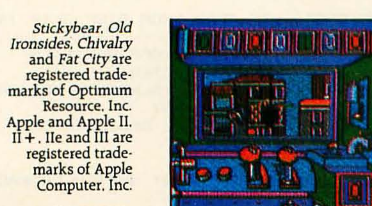


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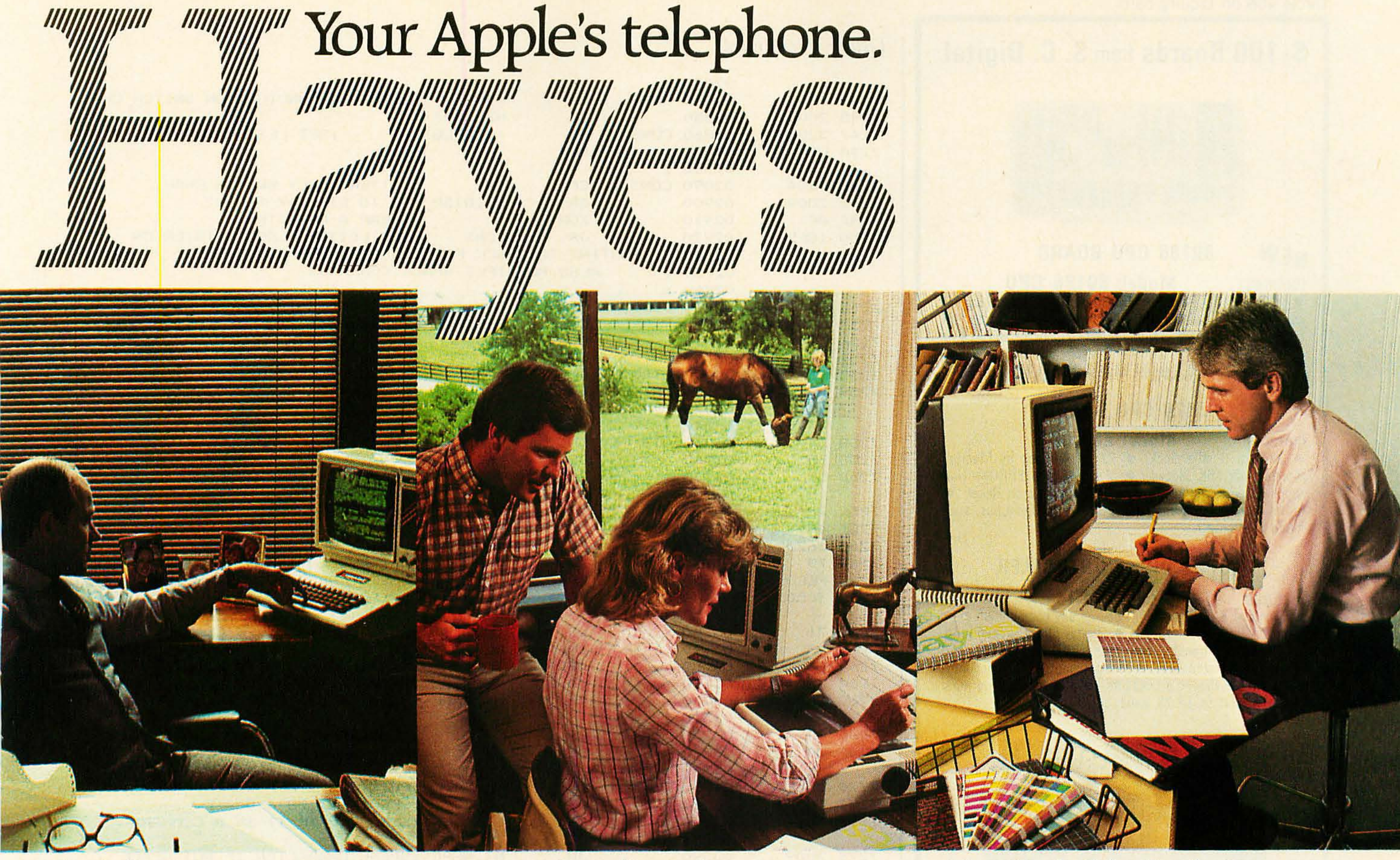


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Listing 1 continued:

```
                 ;
70EF 2AF870              LD      HL,(TKBDR)      ;SET NEW KEYBOARD VECTOR
70F2 221640              LD      (KBDADR),HL
70F5 C9                  RET
                 ;
70F6             COMREG  DEFS    2        ;COMMAND ADDRESS REG
70F8             TKBDR   DEFS    2        ;KEYBOARD VECTOR REG
                 ;
70FA 42          COMD    DEFM    'BASIC'
70FF 0D                  DEFB    0DH
7100 0D                  DEFB    0DH      ;RETURN FOR # OF FILES ?
7101 0D                  DEFB    0DH      ;RETURN FOR MEMORY SIZE ?
7102 52                  DEFM    'RUN"DATE"' ;RUN SPECIFIED PROGRAM
710B 0D          ECOMD   DEFB    0DH      ;END OF COMMAND SEQUENCE
7200                     ORG     7200H
                 ;
7200             BEGIN   EQU     $        ;BEGINNING ADDRESS OF PROGRAM
                 ;
                 ;   ROUTINE TO ECHO KEYBOARD
                 ;
                 ; PROGRAM GOES TO KEYBOARD DRIVER THEN RETURNS TO ECHO
                 ;
                 ;    ALL KEYS EXCEPT ENTER SPOKEN
                 ;    IF SAME LETTER IS IMMEDIATELY SENT TO DISPLAY,
                 ;       IT WILL NOT BE REPEATED
                 ;    SHIFT @ KEY TOGGLES TALKER ON/OFF
                 ;
7200 CDE303      ECHO    CALL    03E3H    ;CALL OLD KEYBOARD ROUTINE
7201             KBDRET  EQU     $-2      ;KEYBOARD ROUTINE ADDRESS
                 ;
7203 B7                  OR      A        ;TEST CHAR RETURNED FROM KEYBOARD
7204 C8                  RET     Z        ;RETURN IF 0 (NO CHARACTER)
                 ;
7205 4F                  LD      C,A      ;SAVE CHARACTER
7206 21DF72      S1      LD      HL,TOGG  ;ECHO ON/OFF REGISTER
7209 FE60                CP      60H      ;TEST FOR SHIFT @
720B 2819                JR      Z,ONOFF  ;TOGGLE TALKER ON/OFF IF SHIFT @
                 ;
720D 34                  INC     (HL)     ;TEST TOGGLE REG FOR 0
720E 35                  DEC     (HL)     ;WHICH MEANS TALKER OFF
720F C8                  RET     Z        ;RETURN IF TALKER OFF
                 ;
7210 23                  INC     HL       ;POINT HL @ LAST CHARACTER REG
7211 77                  LD      (HL),A   ;SAVE CHAR
                 ;
7212 23                  INC     HL       ;POINT HL @ KEYBOARD REGISTER
7213 34                  INC     (HL)     ;SET KEYBOARD REGISTER
                 ;
7214 23                  INC     HL       ;POINT HL @ SPACE FLAG REGISTER
7215 23                  INC     HL       ;POINT HL @ LETTER FLAG REGISTER
7216 CBFE                SET     7,(HL)   ;SET LETTER FLAG REGISTER
                 ;
7218 C5                  PUSH    BC
7219 CD8372      F11     CALL    FIND     ;SPEAK LETTER OR COMMAND
721C C1                  POP     BC
721D FE0D                CP      0DH      ;SEE IF A REG RETURNS WITH C/R
721F 2803                JR      Z,TKRET  ;JUMP IF IT DOES
                 ;
7221 CDC672      T2      CALL    CR       ;OTHERWISE SEND C/R
7224 79          TKRET   LD      A,C      ;RECOVER ORIGINAL CHARACTER
7225 C9                  RET
                 ;
                 ;    ROUTINE TO TURN TALKER OFF OR ON IF SHIFT @ KEYS HIT
                 ;
7226 AF          ONOFF   XOR     A        ;CLEAR A REG
7227 BE                  CP      (HL)     ;TEST TOGGLE REG FOR 0 (OFF)
7228 77                  LD      (HL),A   ;SET TOGGLE REG TO 0
7229 79                  LD      A,C      ;RECOVER ORIGINAL CHAR (60H)
722A C0                  RET     NZ       ;RETURN IF TOGGLE REG WAS NOT 0
722B 34                  INC     (HL)     ;OTHERWISE SET TOGGLE REG TO 1
722C C9                  RET
                 ;  ROUTINE TO READ TEXT THAT IS SENT TO THE DISPLAY
                 ;
                 ;CHARACTER IS SENT TO TALKER BEFORE IT GOES TO DISPLAY
                 ;    COMMANDS NOT SPOKEN BUT CARRAIGE RETURN (C/R) SENT
                 ;    AUTOMATIC C/R IF 2 CONSEQUTIVE SPACES
                 ;    WILL NOT REPEAT CHAR JUST ENTERED ON KEYBOARD
                 ;    CHAR 07 TURNS TALKER ON
                 ;    CHAR 06 TURNS TALKER OFF
                 ;    CHAR 05 SPEAKS BOTH LETTERS & PUNCTUATION
                 ;    CHAR 04 SPEAKS LETTERS ONLY
                 ;
722D 3829        TCRT    JR      C,DISP   ;IF READ FROM DISP SKIP TALKER
                 ;
722F 21DF72      S2      LD      HL,TOGG  ;TALKER ON/OFF REGISTER
7232 79                  LD      A,C      ;NEW CHARACTER
7233 FE07                CP      07H      ;TEST FOR TALKER ON SWITCH CHAR
7235 2003                JR      NZ,CON1  ;JUMP IF NOT
7237 3601                LD      (HL),1   ;SET TOGGLE REGISTER ON
7239 C9                  RET              ;RETURN
                 ;
723A 3016        CON1    JR      NC,CONT  ;SKIP IF NOT SWITCH CHARACTER
                 ;
723C FE06                CP      06H      ;TEST FOR TALKER OFF SWITCH CHAR
723E 2003                JR      NZ,CON2  ;JUMP IF NOT
7240 3600                LD      (HL),0   ;SET TOGGLE REGISTER OFF
7242 C9                  RET
```

Listing 1 continued on page 460



"Thanks for the prompt reply. Sure was a lot faster than waiting for the mail!"

"Gary: The pedigrees for next week's auction are as follows..."

"Attn. Prod., Sales, Purch.: Recommend 50% blue, 30% red screen for closest match."

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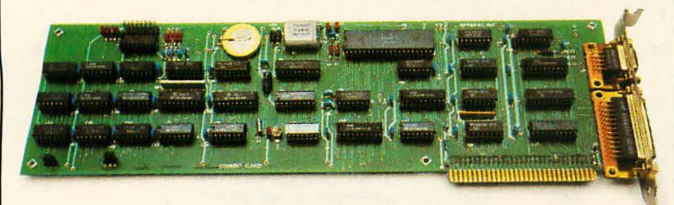
```
                ;
7243 FE05       CON2    CP      05H       ;LETTER & PUNCTUATION SWITCH CHAR
7245 2004               JR      NZ,CON3
7247 32E372     CONS    LD      (LTRFLG),A      ;SET LETTER FLAG REGISTER
724A C9                 RET
                ;
724B FE04       CON3    CP      04H       ;LETTERS ONLY SWITCH CHAR
724D 2009               JR      NZ,DISP ;GO TO DISPLAY IF NOT
724F AF                 XOR     A         ;CLEAR A REGISTER
7250 18F5               JR      CONS      ;SET LETTER FLAG REGISTER ON
                ;   ROUTINE TO CHECK FOR COMMANDS SENT TO DISPLAY
                ;        ALSO MULTIPLE SPACE COMMANDS
                ;
7252 C5         CONT    PUSH    BC
7253 CD5B72             CALL    DISTLK  ;SPEAK CHARACTER SENT TO DISPLAY
7256 C1                 POP     BC
7257 AF                 XOR     A         ;CLEAR  CARRY
7258 C35804     DISP    JP      458H      ;GO TO DISPLAY DRIVER
7259            CRTRET  EQU     $-2       ;DISPLAY DRIVER ADDRESS
                ;
                ;
725B 34         DISTLK  INC     (HL)      ;TEST TOGGLE REG FOR 0
725C 35                 DEC     (HL)
725D C8                 RET     Z         ;RETURN IF TALKER OFF
                ;
725E 23                 INC     HL        ;POINT HL @ LAST CHARACTER REG
725F 46                 LD      B,(HL)  ;LAST CHARACTER
7260 3620               LD      (HL),20H ;STORE SPACE IN LAST CHAR REG
7262 79                 LD      A,C       ;GET NEW CHARACTER
7263 FEC0               CP      0C0H      ;CHECK FOR SPACE COMPRESSION CODE
7265 305B               JR      NC,SPACE ;SEND SPACE IF TRUE
                ;
7267 71                 LD      (HL),C  ;LOAD REG WITH NEW CHARACTER
7268 23                 INC     HL        ;POINT HL @ KEYBOARD FLAG REGISTER
7269 35                 DEC     (HL)      ;TEST FOR KEYBOARD FLAG
726A 3600               LD      (HL),0  ;RESET KEYBOARD FLAG REGISTER
726C 2002               JR      NZ,LNFK ;JUMP IF LAST INPUT NOT FROM KBD
                ;
726E B8                 CP      B         ;COMPARE LAST & NEW CHARACTERS
726F C8                 RET     Z         ;RETURN IF SAME
                ;
7270 23         LNFK    INC     HL        ;POINT HL @ SPACE FLAG REG
7271 FE20               CP      20H       ;SEE IF IT IS A SPACE
7273 3851               JR      C,CR      ;SEND C/R IF IT IS A COMMAND
                ;
7275 2009               JR      NZ,NSPC ;SPEAK CHARACTER IF NOT SPACE
                ;
7277 B8                 CP      B         ;IF IT IS A SPACE SEE IF LAST
7278 204E               JR      NZ,SEND ;CHAR WAS ALSO & SEND IF NOT
                ;
727A 34                 INC     (HL)      ;TEST SPACE FLAG REG
727B 35                 DEC     (HL)
727C C8                 RET     Z         ;RETURN IF SPACE FLAG SET
                ;
727D 34                 INC     (HL)      ;SET SPACE FLAG
727E 1846               JR      CR        ;SEND C/R
                ;
7280 3600       NSPC    LD      (HL),0  ;RESET SPACE FLAG REGISTER
7282 23                 INC     HL        ;POINT HL @ LETTER FLAG REGISTER
                ; ROUTINE TO SPEAK CHARACTERS
                ;
                ; COMMANDS SPOKEN IF FROM KEYBOARD
                ; PUNCTUATION SPOKEN ONLY IF LETTER FLAG NOT 0
                ; CHARACTERS ABOVE 7BH ARE IGNORED
                ;
7283 FE7B       FIND    CP      7BH
7285 D0                 RET     NC        ;RETURN (IGNORE) IF CHAR >7BH
                ;
                ; SEE IF CHAR =5BH (UP ARROW) THIS IS THE ONLY CHARACTER
                ;      RECOGNIZED BETWEEN 5AH & 60H
                ;
7286 FE5B               CP      5BH
7288 280C               JR      Z,WORD             ;A=5BH
                ;
                ; SEE IF CHARACTER IS A LETTER (UPPER OR LOWER CASE)
                ;
728A FE41               CP      'A'
728C 303A               JR      NC,SEND            ;41H<A<7AH
                ;
                ; SEE IF CHARACTER IS A PUNCTUATION MARK :;<=>?@
                ;
728E FE3A               CP      ':'
7290 3004               JR      NC,WORD            ;39H<A<41H
                ;
                ; SEE IF CHARACTER IS A NUMBER
                ;
7292 FE30               CP      '0'
7294 3032               JR      NC,SEND            ;2FH<A<3AH
                ;
                ;OTHERWISE CHAR MUST BE A COMMAND OR PUNCTUATION MARK
                ;
                ;
                ; ROUTINE TO FIND THE PROPER WORD TO SPEAK
                ;    FOR COMMANDS & PUNCTUATION
                ;
7296 46         WORD    LD      B,(HL)  ;SAVE LETTER FLAG FOR USE LATER
7297 CBBE               RES     7,(HL)  ;CLEAR KBD FLAG IN LETTER FLAG REG
                ;
7299 23         TERM    INC     HL        ;POINT HL TO BEGINNING OF TABLE
```

Listing 1 continued on page 462

THE ONE AND ONLY

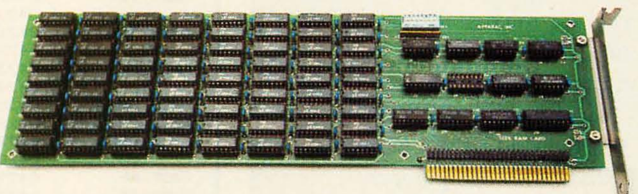
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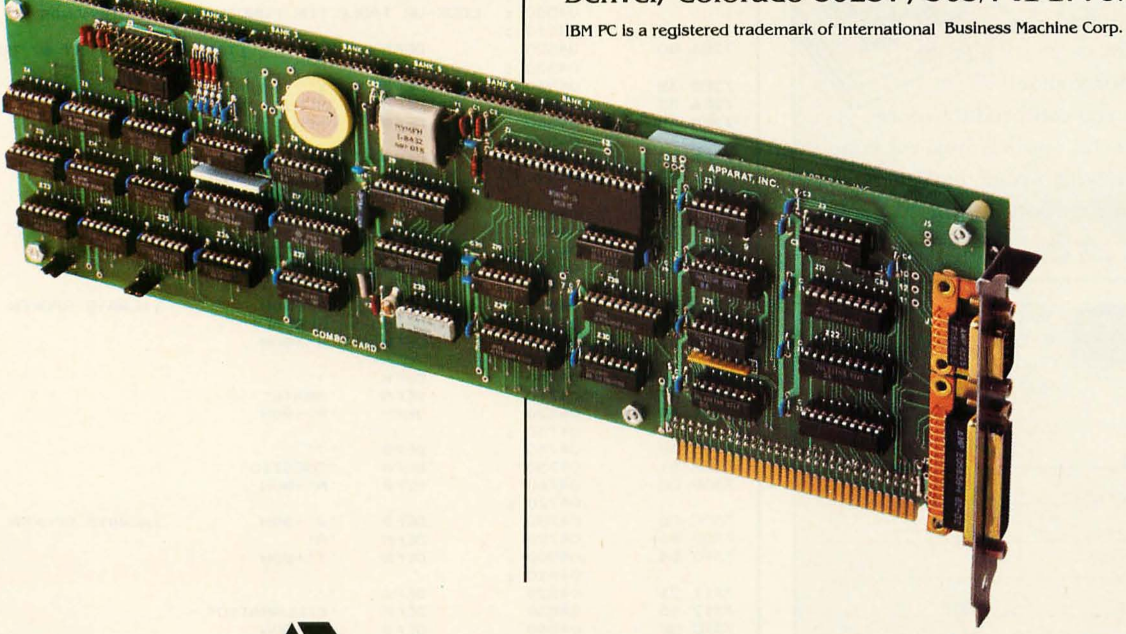
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Apparat, Inc.

Circle 38 on inquiry card.

Listing 1 continued:

```
729A CB7E              BIT     7,(HL)  ;FIND TERMINATING CHAR
729C 23                INC     HL
729D 28FB              JR      Z,$-3
                 ;
729F 7E                LD      A,(HL)  ;GET CHARACTER FROM TABLE
72A0 E67F              AND     7FH     ;REMOVE FLAG BIT
72A2 C8                RET     Z       ;RETURN IF END OF TABLE
                 ;
72A3 B9                CP      C       ;COMPARE TO NEW CHARACTER
72A4 20F3              JR      NZ,TERM ;CONTINUE SEARCH IF NOT SAME
72A6 78                LD      A,B     ;TEST LETTER FLAG TO SEE IF ALL
72A7 B7                OR      A       ;PUNCT TO BE SPOKEN
72A8 2004              JR      NZ,$+6  ;SEND REGARDLESS IF SET
72AA CB7E              BIT     7,(HL)  ;CHECK CHAR FLAG IN TABLE
72AC 2814              JR      Z,SPACE ;SEND SPACE IF CHAR NOT ALLOWED
                 ; SPEAK WORD WHEN CHARACTER FOUND
                 ;
72AE CDC272            CALL    SPACE   ;SEND SPACE TO SEPARATE WORD
72B1 23          SPKWD INC     HL
72B2 7E                LD      A,(HL)
72B3 CDC872      T1    CALL    SEND    ;SEND WORD
72B6 CB7E              BIT     7,(HL)  ;CHECK FOR TERMINATOR
72B8 28F7              JR      Z,SPKWD ;CONTINUE IF NOT TERMINATOR
                 ;
72BA 7E                LD      A,(HL)
72BB FEA0              CP      0A0H    ;IF TERMINATOR = A0H CONTINUE
72BD 2007              JR      NZ,CR   ;OTHERWISE SEND C/R
72BF 23                INC     HL
72C0 18EF              JR      SPKWD
                 ;
                 ;
                 ; ROUTINE TO SEND CHARACTER TO VOTRAX TYPE-N-TALK
                 ;
72C2 3E20        SPACE LD      A,20H   ;SEND SPACE TO VOTRAX
72C4 1802              JR      SEND
                 ;
72C6 3E0D        CR    LD      A,0DH   ;SEND C/R TO VOTRAX
                 ;
72C8 F5          SEND  PUSH    AF      ;SAVE CHARACTER
                 ;
72C9 DBEA        SEND1 IN      A,(0EAH) ;CHECK RS-232 STATUS
72CB CB77              BIT     6,A
72CD 28FA              JR      Z,SEND1 ;LOOP IF RS-232 NOT READY
                 ;
72CF AF                XOR     A       ;DELAY FOR ONE FRAME GIVE VOTRAX
72D0 3D          DELAY DEC     A       ;TIME TO RESET CLEAR TO SEND LINE
72D1 20FD              JR      NZ,DELAY
                 ;
72D3 DBE8        SEND2 IN      A,(0E8H) ;SEE IF VOTRAX READY TO RECEIVE
72D5 CB7F              BIT     7,A     ;CLEAR TO SEND (CTS) TRUE
72D7 20FA              JR      NZ,SEND2 ;LOOP IF NOT READY
                 ;
72D9 F1                POP     AF      ;RESTORE CHARACTER
72DA E67F              AND     7FH     ;REMOVE FLAG BIT
72DC D3EB              OUT     (0EBH),A ;SEND CHARACTER TO RS-232
72DE C9                RET
                 ;     FLAG REGISTERS
                 ;
72DF 01          TOGG  DEFB    1       ;TALKER ON/OFF FLAG REGISTER
72E0 00                DEFB    0       ;LAST CHARACTER REGISTER
72E1 00                DEFB    0       ;KEYBOARD REGISTER
72E2 00                DEFB    0       ;SPACE FLAG REGISTER
72E3 01          LTRFLG DEFB   1       ;LETTERS & NUMBERS ONLY FLAG REG
                 ;
                 ;  LOOK-UP TABLE FOR PUNCTUATION & COMMANDS
                 ;
72E4 80                DEFB    80H     ;TABLE MUST START W/ 80H
                 ;
72E5 3B                DEFB    ';'
72E6 53                DEFM    'SEMI'
72EA A0                DEFB    0A0H
                 ;
72EB 3A                DEFB    ':'
72EC 43                DEFM    'COLO'
72F0 CE                DEFB    'N'+80H
                 ;
72F1 3C                DEFB    '<'
72F2 4C                DEFM    'LES'
72F5 D3                DEFB    'S'+80H
                 ;
72F6 BD                DEFB    '='+80H         ;ALWAYS SPOKEN
72F7 45                DEFM    'EEQUAL'
72FD D3                DEFB    'S'+80H
                 ;
72FE 3E                DEFB    '>'
72FF 47                DEFM    'GRATE'
7304 D2                DEFB    'R'+80H
                 ;
7305 3F                DEFB    '?'
7306 51                DEFM    'QUESTIO'
730D CE                DEFB    'N'+80H
                 ;
730E C0                DEFB    '@'+80H         ;ALWAYS SPOKEN
730F 41                DEFM    'A'
7310 D4                DEFB    'T'+80H
                 ;
7311 21                DEFB    '!'
7312 45                DEFM    'EXCLAMATIO'
731C CE                DEFB    'N'+80H
```

Listing 1 continued on page 464

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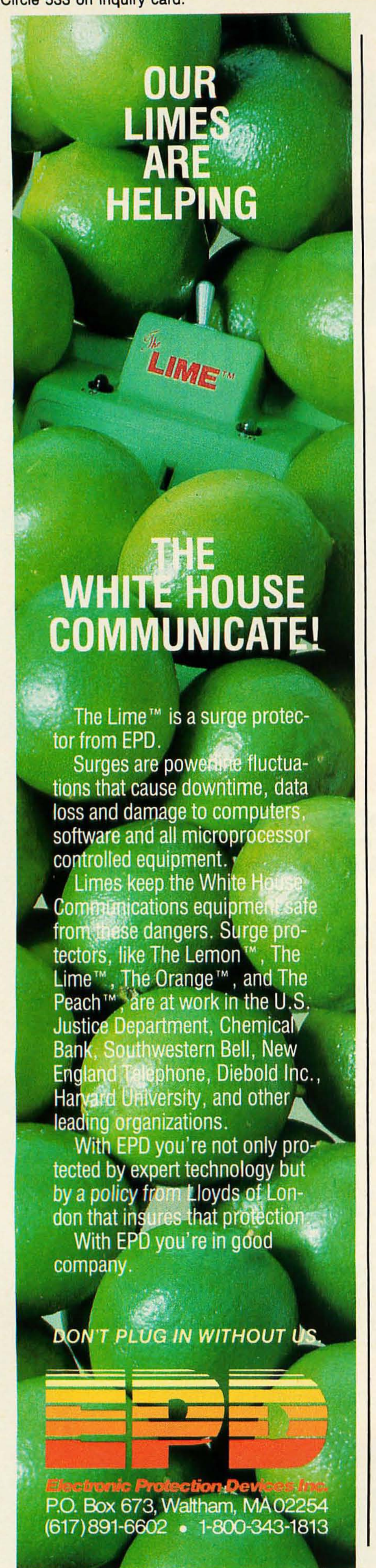
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Circle 213 on inquiry card.



Listing 1 continued:

```
           ;
731D 22          DEFB    '"'
731E 51          DEFM    'QUOT'
7322 C5          DEFB    'E'+80H
           ;
7323 A3          DEFB    '#'+80H          ;ALWAYS SPOKEN
7324 4E          DEFM    'NUMBE'
7329 D2          DEFB    'R'+80H
           ;
732A A4          DEFB    '$'+80H          ;ALWAYS SPOKEN
732B 44          DEFM    'DOLLA'
7330 D2          DEFB    'R'+80H
           ;
7331 A5          DEFB    '%'+80H          ;ALWAYS SPOKEN
7332 50          DEFM    'PERCEN'
7338 D4          DEFB    'T'+80H
7339 A6          DEFB    '&'+80H          ;ALWAYS SPOKEN
733A 41          DEFM    'AN'
733C C4          DEFB    'D'+80H
           ;
733D 27          DEFB    '''
733E 41          DEFM    'APOSTROF'
7346 D9          DEFB    'Y'+80H
           ;
7347 29          DEFB    ')'
7348 43          DEFM    'CLOSE'
734D A0          DEFB    0A0H
           ;
734E 28          DEFB    '('
734F 50          DEFM    'PARA'
7353 CE          DEFB    'N'+80H
           ;
7354 2A          DEFB    '*'
7355 41          DEFM    'ASTERIS'
735C CB          DEFB    'K'+80H
           ;
735D AB          DEFB    '+'+80H          ;ALWAYS SPOKEN
735E 50          DEFM    'PLU'
7361 D3          DEFB    'S'+80H
           ;
7362 2C          DEFB    ','
7363 43          DEFM    'COMM'
7367 C1          DEFB    'A'+80H
           ;
7368 2D          DEFB    '-'
7369 4D          DEFM    'MYNA'           ;COULD BE "DASH"
736D D3          DEFB    'S'+80H
           ;
736E 2E          DEFB    '.'              ;COULD BE "PERIOD"
736F 50          DEFM    'POIN'
7373 D4          DEFB    'T'+80H
           ;
7374 AF          DEFB    '/'+80H          ;ALWAYS SPOKEN
7375 53          DEFM    'SLAS'
7379 C8          DEFB    'H'+80H
           ;
737A 1B          DEFB    1BH
737B 53          DEFM    'SHIFT'
7380 A0          DEFB    0A0H
           ;
7381 5B          DEFB    5BH
7382 55          DEFM    'U'
7383 D0          DEFB    'P'+80H
           ;
7384 1F          DEFB    1FH
7385 43          DEFM    'CLEA'
7389 D2          DEFB    'R'+80H
           ;
738A 20          DEFB    ' '
738B 53          DEFM    'SPAC'
738F C5          DEFB    'E'+80H
           ;
7390 01          DEFB    01H
7391 42          DEFM    'BREA'
7395 CB          DEFB    'K'+80H
7396 18          DEFB    18H
7397 53          DEFM    'SHIFT'
739C A0          DEFB    0A0H
           ;
739D 08          DEFB    08H
739E 42          DEFM    'BA'
73A0 C3          DEFB    'C'+80H
           ;
73A1 19          DEFB    19H
73A2 53          DEFM    'SHIFT'
73A7 A0          DEFB    0A0H
           ;
73A8 09          DEFB    09H
73A9 54          DEFM    'TA'
73AB C2          DEFB    'B'+80H
           ;
73AC 0A          DEFB    0AH
73AD 44          DEFM    'DOW'
73B0 CE          DEFB    'N'+80H
           ;
73B1 0D          DEFB    0DH
73B2 80          DEFB    080H
           ;
```

Listing 1 continued on page 466

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Listing 1 continued:

```
73B3 00        05850         NOP                ;TABLE MUST END W/ 00
               05860 ;
73B4           05870 LAST    EQU     $          ;END OF ROUTINE
               05880 ;
7010           05890         END     START
00000 TOTAL ERRORS
```

```
                                   SYMBOL TABLE

BASIC   70A6 01390    01360
BEGIN   7200 01970    00590 00760 01310 01580
CH1     70ED 01800    01770
CHAIN   70DC 01700    01630
COMD    70FA 01900    01660
COMREG  70F6 01870    01670 01700 01730
CON1    723A 02770    02730
CON2    7243 02840    02800
CON3    724B 02890    02850
CONS    7247 02860    00940 02920
CONT    7252 02970    00900 02770
CR      72C6 04210    01090 02430 03270 03390 04110
CRTADR  401E 00240    00290 01220 01490
CRTRET  7259 03020    00300
DELAY   72D0 04300    04310
DISP    7258 03010    02680 02900
DISTLK  725B 03050    00880 02980
ECHO    7200 02100    01240 01510
ECOMD   710B 01950    01740
F11     7219 02380    00860
FIND    7283 03500    00840 02380
HIMEM1  4049 00210    00530 00670
HIMEM3  4411 00220    00570 00650
KBDADR  4016 00230    00320 01260 01640 01840
KBDRET  7201 02110    00330
LAST    73B4 05870    00590
LNFK    7270 03250    03200
LTRFLG  72E3 04480    00920 02860
NSPC    7280 03410    03290
ONOFF   7226 02490    02210
S1      7206 02190    00980
S2      722F 02700    00990
SEND    72C8 04230    00460 00480 01050 03320 03620 03720 04050
                      04190
SEND1   72C9 04250    04270
SEND2   72D3 04330    04350
SET1    703D 00590    00560
SET2    704C 00670    00640
SET3    704F 00690    00660
SPACE   72C2 04180    01130 03140 03980 04020
SPKWD   72B1 04030    01150 04070 04130
START   7010 00290    05890
T1      72B3 04050    01070
T2      7221 02430    01110
TCRT    722D 02680    01200 01470
TERM    7299 03830    03930
TKBDR   70F8 01880    01530 01830
TKRET   7224 02440    02410
TOGG    72DF 04440    00960 02190 02700
WORD    7296 03800    03570 03670
```

Text continued from page 454:

the Talker program can execute. Knowing how and when to do this is difficult for a blind operator because there are no audio prompts. A patch to eliminate this problem was written by John Ratzlaff and appeared in the September 1982 issue of *80 Micro* (page 34). It is: patch*0:0 (Add=4EA9, Find=CA, Chg=C3).

Don't use the DO command and a chain file with TRSDOS because, when the command file is complete, the keyboard vectors are rewritten, bypassing Talker. Use the chain shown in listing 1 or use NEWDOS.

In a cassette system, the memory size must be set using the SYSTEM command before the program can be loaded and further programs run manually.

Regardless of which system you use, the Talker program consists of two major parts: the intercept routines and a relocation/initialization routine. When loaded and run, the initializing routine retrieves the keyboard and video-driver vectors, sets the RS-232C parameters, turns off the retransmission mode of the Type-'N-Talk, relocates the intercept routines to the end of memory, determines if the host computer is a Model I or III and sets the high-memory pointer accordingly, inserts new addresses into the keyboard- and video-vector locations, and exits to DOS. The initialization routine is then discarded,



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and the memory space that it occupies can be reused.

The Keyboard Intercept

If the keyboard driver is called, the character returned from the normal keyboard routine is intercepted before it is sent back to the host program. If the character is a letter or number, it is transmitted to the Type-'N-Talk followed by a carriage return so that it is spoken immediately and no distinction is made between uppercase and lowercase letters (if available). If it is a punctuation mark or control character, it must be translated into a word or the Votrax unit will ignore it. This word is then sent and immediately spoken. Flags are set so that if the same character is immediately sent to the video-display driver, it is not repeated. The Talker program can be toggled off and on by pressing the Shift and @ keys simultaneously. This key combination represents the only command that can be sent to the Talker program directly from the keyboard.

The Video Intercept

If the video-display driver is called, the character is intercepted before it is sent to the display, and unless it is one of the special program control characters (numbers 04 through 07), it will be spoken and then sent on to the display. If the video driver is being used to read a character already on the display, the intercept program passes the request to the driver.

The video-intercept routine sends any number or letter (uppercase or lowercase) directly to the Type-'N-Talk. Control codes for the display (such as BACK SPACE and TAB) are not transmitted, but a carriage return is sent in their place, causing the previously transmitted text to be spoken. The carriage return and the space characters are transmitted directly. If two or more consecutive space characters are encountered, the first space is sent, a carriage return is sent in place of the second space character, and subsequent consecutive spaces are ignored.

Punctuation marks are translated into words and sent to the Type-'N-Talk preceded by a space and followed by a carriage return, provided that the intercept routine has not been instructed to ignore them. The marks that are ignored and their pronunciation can be easily changed by modifying the lookup table in the program. For example, you may want to substitute PERIOD for POINT or DASH for MINUS.

All graphics codes are ignored. Space-compression codes result in a single space being sent to the Votrax unit. The special character codes of the Model III (numbers 192 through 255) are considered space-compression codes.

Four special codes can be used to control the intercept program. The BASIC statement PRINT CHR$(4) will cause punctuation marks to be ignored; PRINT CHR$(5) causes them to be spoken. This command has no effect on punctuation characters originating from the keyboard. PRINT CHR$(6) causes the program to stop talking, and PRINT CHR$(7)

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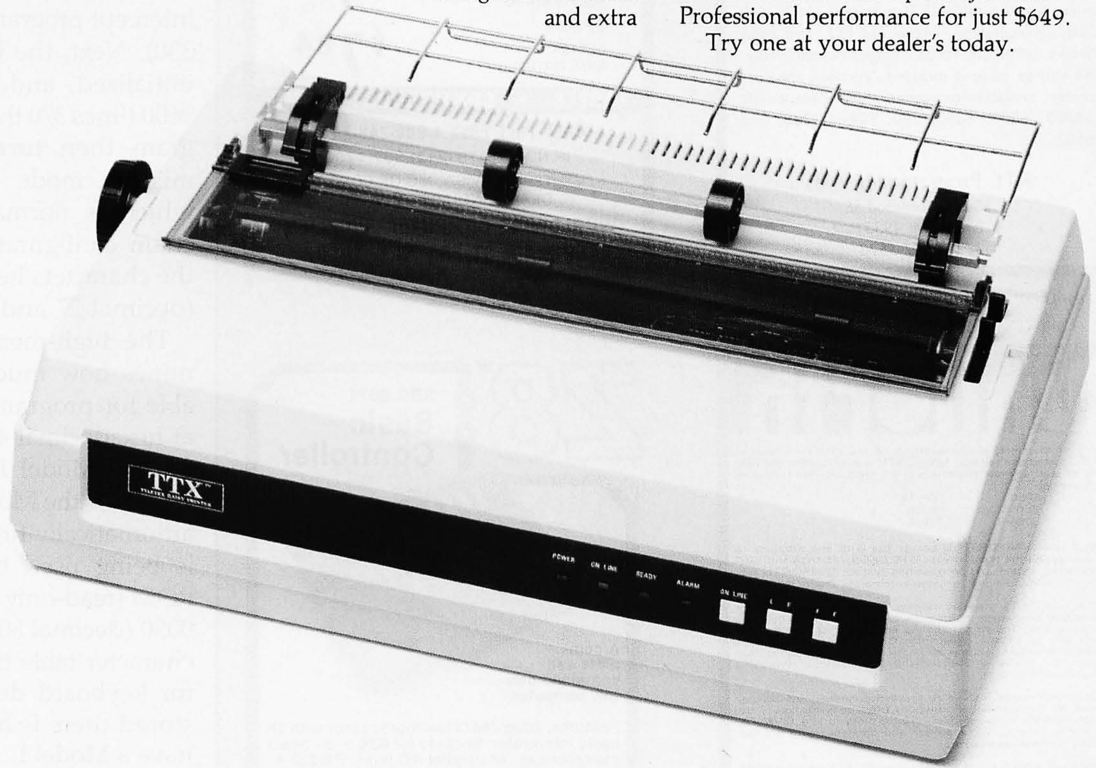
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Circle 489 on inquiry card.

Circle 267 on inquiry card.

starts the Type-'N-Talk speaking again. These commands are not sent to the display because they would be ignored anyway.

As I mentioned before, the two major parts of the Talker program are the relocation/initialization routine and the intercept routine. Descriptions of these routines follow (see listing 1).

The Relocation/Initialization Routine

The Talker program is loaded at hexadecimal 7000 (decimal 28672) and starts at 7010, which allows you to use the program on computers with 16K, 32K, or 48K bytes of memory without changes. The message in line 140 serves as a check on the date of the program. I have the program on several different disks and I find it helpful to have a clear ASCII (American National Standard Code for Information Interchange) date that I can read with DEBUG to ensure that I have the latest version.

First, the normal keyboard and display-driver addresses are taken from the vector locations and stored in the intercept program (lines 290 through 330). Next, the RS-232C interface is initialized, and the bps rate set to 9600 (lines 370 through 410). The program then turns off the retransmission mode of the synthesizer, which is normally used in daisy-chain configurations, by sending it the characters hexadecimal 1B and 14 (decimal 27 and 20).

The high-memory pointer determines how much memory is available for program use and is located at hexadecimal 4049 (decimal 16457) for the Model I and 4411 (decimal 17425) for the Model III. The program automatically finds which computer is being used by looking into the ROM (read-only memory) at location 0050 (decimal 80), where the special character table is located in Model I for keyboard decoding. If the byte stored there is hexadecimal 0D, you have a Model I; if not it's a Model III (lines 530 through 570). I have included this capability because I regularly run the program on both computers, and it is a nuisance to keep changing the pointer address

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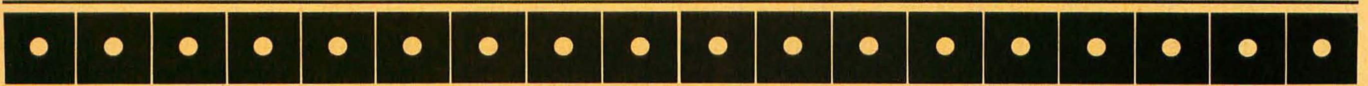
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back and forth. If the program was to be run on only one or the other, this check could be eliminated, but because this part of the program eventually is discarded, the extra memory use is not a factor. Once the model type is determined, the length of the intercept routine (LAST − BEGIN = 436 bytes) is subtracted from the existing high-memory pointer, and this new address becomes the end of usable memory and is stored in the pointer location (lines 590 through 670). The intercept routine starts at this address plus 1 byte when it is relocated. For example, if the high-memory pointer were 32767, it would become 32767 − 436 or 32331, and the intercept routine would start at 32332 when it was relocated.

The difference between the new starting address (32332 in the example) and the present starting address (hexadecimal 7200 or decimal 29184) of the intercept routine is then calculated. Now various absolute addresses (subroutine calls and flag register addresses) are adjusted to reflect the new location (lines 760 through 1150), and the new locations of the keyboard and display intercepts are written back into the driver vector locations (lines 1200 through 1260). At last the intercept routine is transferred to the new location. The HL register pair is then loaded with the address of a DOS command string, and a jump to NEWDOS automatically starts execution of a BASIC program called "Date," a program I wrote that asks for the date from the operator, reads it back in English, and then runs a menu of available programs.

Remember that I promised to give a chaining routine for TRSDOS if you read far enough? Well, lines 1470 through 1950 do just that. Instead of the keyboard intercept vector being immediately loaded in the driver location, it is stored temporarily, and the location of a keyboard chain routine set in the driver vector's place. Whenever the keyboard is called, this new routine sends back a character instead. It types in "BASIC," answers the NUMBER OF FILES? and MEMORY SIZE? questions, and types in the name of the BASIC program to be run automatically. Before returning with the last character, however, it replaces the keyboard driver vector with the address of the keyboard intercept routine. If you use this chaining routine, remember to assemble it in place of lines 1200 through 1400 and insert the name of the program to be run in place of Date.

The relocation and initialization are now complete, and this part of the program can be written over by BASIC.

The Intercept Routines

For clarity, the intercept routines are broken into three parts: the keyboard intercept, the video intercept, and their partner, the Find routine. Remember that, although listing 1 shows the program assembled at hexadecimal 7200 (decimal 29184), it is actually residing at the end of high memory.

The Find routine sends a character to the synthesizer or translates it into a word and transmits it.

The routine that echoes the keyboard is called, as you might suspect, Echo. This routine first calls the original keyboard routine to get a character.

Now the fun begins. First the character is checked to see if it is a null (00), which would indicate that no key had been pressed (lines 2150 through 2160). If this is the case, the program returns immediately to the host program as it normally would. If there is a character, it is then compared to hexadecimal 60 (the shift @ key), which is used to toggle Talker on and off (lines 2200 through 2210). If it is the hexadecimal 60, the routine jumps to lines 2490 through 2550 to turn on Talker; otherwise the TOGGLE flag register is checked to see if Talker has already been turned off (lines 2230 through 2250). Assuming that Talker is still on, the routine saves the character in the LAST CHARACTER register and sets the KEYBOARD flag register (lines 2270 through 2310). The video-intercept routine uses these registers to prevent repetition of a character sent to the display after being input from the keyboard. Next, bit 7 of the LETTER flag register is set to make sure that all punctuation is spoken even though the PUNCTUATION OFF mode has been selected (lines 2330 through 2350).

The character is then passed to the Find routine, which either sends it directly to the synthesizer or translates it into a word and transmits it. Upon return from this routine, a test checks whether the last character sent to Type-'N-Talk was a carriage return (hexadecimal 0D), and if it was not, a carriage return is sent (lines 2400 through 2450). Finally, the original character from the keyboard is returned to the host program.

The video-intercept routine is straightforward in that you can intercept the character on its way to the display, but many decisions and assumptions must be made before the job is complete. First, the condition codes must be examined to determine if the video driver was called to read a character already on the display. The carry flag indicates this condition and, if that flag is set, the routine continues directly to the video-display driver (line 2680). Assuming that the host program is really trying to write something on the display, the intercept routine next checks to see if the character is one of the special codes used to control Talker (see table 1) and, if it is, the appropriate action is taken (lines 2700 through 2920). The intercept routine returns directly to the host program when these codes occur because they are ignored by the normal display routine.

If the character is not a control code, the Distlk (display talker) subroutine is called. This routine first tests the TOGGLE flag register to see if the Votrax unit is still talking and returns to the host program if the unit is quiet (lines 3050 through 3070). The character in the LAST CHARACTER register is removed and saved temporarily (you'll need it later), and a space (hexadecimal 20)

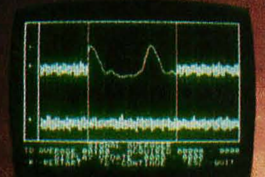
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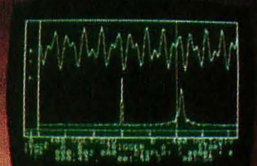
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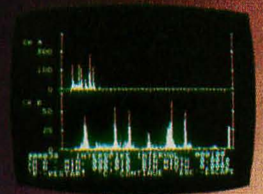
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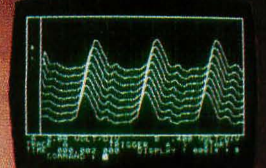




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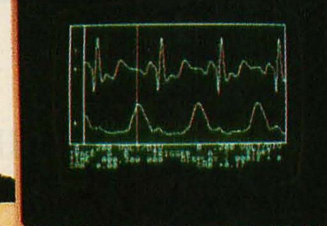




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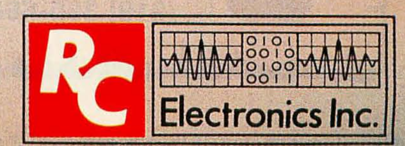


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is stored in its place. The character to be displayed is then tested, and if it is a space-compression code (hexadecimal C0 through FF, decimal 192 through 255), a space is sent to the synthesizer, and the compression code is sent on to the display (lines 3090 through 3140). If it is not, the new character is put in the LAST CHARACTER register for subsequent reference.

The next section (lines 3170 through 3230) eliminates repetition of a character that has just been input from the keyboard. If the keyboard flag register is not 0 and the new and last characters are the same, the new character is ignored. (There is a possibility, of course, that the last character from the keyboard was never sent to the display and that this character is the first letter of a new prompt. Unfortunately, if this is the case, the second one will still be ignored.)

The next test determines whether the new character is a control code to the display (TAB or BACK SPACE, for example), in which case a carriage return is sent to the synthesizer. Otherwise, the program determines whether the host program is sending consecutive spaces and, if so, it ignores all but the first one. Here, execution jumps to line 3410 if the new character is not a space. If it is a space, it is compared with the last character to see if you just sent one. If you did not, you send it along to the synthesizer. Otherwise, to prevent sending lines of nothing, you must test the SPACE FLAG register, which, when it is not 0, indicates that at least two consecutive spaces have occurred. If it is 0, you set it and send a carriage return; otherwise, you ignore the space and return (lines 3250 through 3390).

Assuming that execution reaches line 3410, you clear the SPACE FLAG register, and the character or the word for it is sent to the Type-'N-Talk by the Find routine (lines 3410 through 3420). The Find routine provides the return and, after clearing the carry (which you may have set), the character is sent on to the original video driver and then home to the host program (lines 2990 through 3010).

The Find Routine

The Find routine checks an incoming character to see if it is a letter or number, translates it if it is not, and sends it to the synthesizer. (Refer to table 2 for the characters that are translated.) Lines 3500 through 3720 do the actual testing. If the character is greater than hexadecimal 7B, it is ignored, and 5B (up arrow) is the only character recognized between the uppercase and lowercase letter sets, so if the character falls between hexadecimal 41 (A) and 7A (z), it is transmitted directly. The numbers are handled similarly, and everything else must be made into a word before it can be sent. The translation is done (only if permitted by the LETTER flag) by looking up the character in the table, which is located at lines 4520 through 5850. This is done in lines 3800 through 3980.

A word about the table is in order at this point. First, some misspellings are evident. This is done intentionally



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to correct some pronunciation problems in the Type-'N-Talk. Second, the terminating characters are denoted by adding hexadecimal 80 to the ASCII code for the last letter of the word. (Note that the table must start with hexadecimal 80 and end with 00). Unless this character happens to be A0, the word stops there. If it is A0, the next character is skipped, and the reading continues, enabling you to save space by using SEMI COLON for both semicolon and colon, for example. The routine in lines 4020 through 4130 sorts this out. A space is transmitted before the word, and a carriage return follows it. Third, hexadecimal 80 (decimal 128) is added to the codes for some of the punctuation. These are the punctuation marks spoken even in the PUNCTUATION OFF mode. If you want to change any of these, add or subtract 80 as required.

The characters are transmitted to the RS-232C interface in lines 4180 through 4400. The character to be sent is saved temporarily, the status of the RS-232C transmitter is checked, a delay is inserted to ensure that the Type-'N-Talk has had time to turn off the CLEAR TO SEND line if it is talking, and the status of this line is tested. If everything is ready, the character is sent and the subroutine returns.

The flag registers (lines 4440 through 4480) are located just before the word table in memory and should be kept in that order because they are accessed by indexing the HL register pair. Eventually HL is left pointing at the start of the table. Note that if the TOGG register is set to 0 when the program is assembled, the Talker program will initially be off and must be turned on by the shift @ key or by sending 07 to the display. I use this to prevent the BASIC headers from being spoken while the system is being initialized. The PUNCTUATION ONLY mode may be similarly set by initializing the LTRFLG to 0.

New Speech Synthesizers

Since we purchased our Type-'N-Talk, several improved synthesizers have appeared on the market. Votrax has introduced a new model (and reduced the price of the old one), and Steve Ciarcia has published two articles in BYTE (September and October 1982) describing a unit called Microvox, which is available in kit form from Micromint Inc. and as a finished unit called the Intex-Talker from Intex Micro Systems Inc. In addition, a company called Street Electronics Corporation has released a unit called the Echo Speech Synthesizer. All of these units have improved text-to-speech algorithms and include additional features such as intonation and inflection, internal speakers, parallel interfaces, and pronounced punctuation. Although I have not used any of them yet, I don't think it will be hard to modify Talker to accommodate the added features. The elimination of the lookup table for punctuation would be the first step, along with the addition of control codes to control speech rate and inflection. I am sure that the features of Talker will be useful with the new synthesizers.

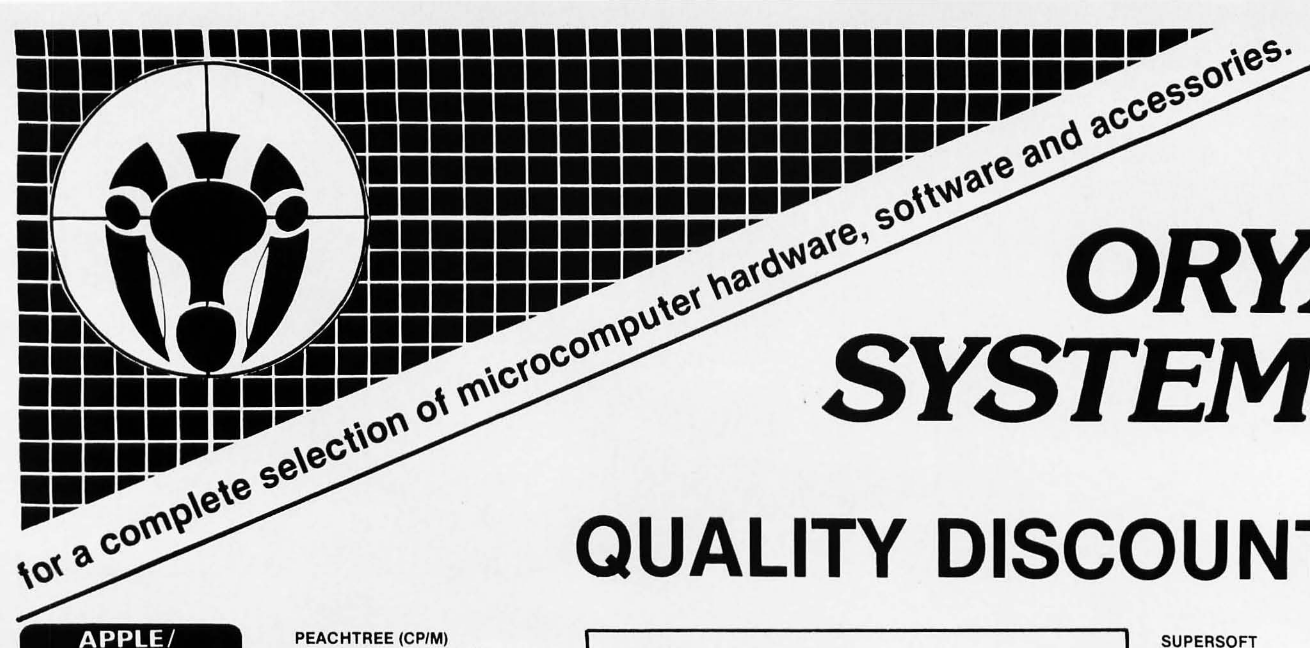
Suzanne wants me to finish a cooking and recipe program for her and has already stated that she doesn't want to have to run from the kitchen (downstairs) to the computer room (upstairs) when she is using it. This means that I will have to develop a remote terminal with another synthesizer that she can use in the kitchen, so I may get a chance to try out a new model, after all.

Conclusion

I was once told that if you give a job to a lazy man, he will get it done in the easiest possible manner. This program seems to justify that saying. Talker is a utility routine that loads itself automatically and makes vocal programs only a PRINT statement away. Now I can concentrate on the real task of satisfying my wife's growing demand for more and more programs that substitute speech for sight.■

Heyward Williams is head of the Systems Engineering Department at Alpha Industries Inc. in Woburn, Massachusetts. He can be reached at 57 Franklin St., Derry, NH 03038.

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Bitmaps Speed Data-Handling Tasks

Programming techniques employing bitmaps enhance the speed of list comparison and make short work of file searches

by Eric Sohr

Bitmaps are data structures that can speed data-handling tasks and reduce memory requirements in a variety of programming applications. Specifically, bitmaps—strings of 1s and 0s—can make short work of ordered-list comparisons and file searches.

This article describes programming techniques that evolved during the three years I spent developing a cross-indexing system called LITMAS (literature manipulation system). LITMAS uses bitmaps extensively for data handling and disk files; it runs on the 6502-based Apple II.

To present this material logically, I will begin by describing ordered lists and then bitmap representations of ordered lists. I will also illustrate the speed of bitmap operations when compared to alternative methods of processing and present the 6502 assembly-language coding and documentation. I will conclude with sections on bitmap compression.

Ordered Lists

For our purposes "ordered list" means a set of nonnegative integers such as $L_y = (y_1, y_2, y_3, y_4 \ldots y_n)$, where each $Y_i >= 0$ and where $y_1 < y_2 < y_3 < y_4 \ldots < y_n$.

For example, (1, 8, 16, 21) is an ordered list, while (1, 16, 8, 21) is a set that contains exactly the same elements but is not an ordered list. The elements 16 and 8 are out of sequence in the second set.

Ordered lists are often useful in computer operations. The ordering sequence minimizes the number of tests that must be performed when comparing one list with another. Suppose, for example, that you want to find the common members of two lists: $L_x = (X_1, X_2, X_3, X_4 \ldots X_m)$ and $L_y = (Y_1, Y_2, Y_3, Y_4 \ldots Y_n)$. If the sets are not ordered, you must choose one set and compare each member of that set with each member of the second set. If there are m members of the first set and n members of the second set, you must perform $m \times n$ comparisons between list members. If, however, the two sets are ordered, you need only perform $m+n$ comparisons. Ordering permits you to read each set only once to determine common items. Sorting techniques and algorithms are important research topics because of the time savings possible after the creation of ordered lists. A guarantee of ordering permits critical shortcuts in finding, inserting, and deleting members of a list.

An Algorithm for Examining Two Sequential Lists

The following algorithm can compare two ordered lists. The lists in this case are:

List 1 = $L_x = (X_1, X_2, X_3, X_4 \ldots X_m)$

List 2 = $L_y = (Y_1, Y_2, Y_3, Y_4 \ldots Y_n)$

In computer implementations of this algorithm, two memory locations serve as counters: a is the counter for L_x and b is the counter for L_y. The comparison is completed as soon as the algorithm has operated on all of the elements in either List 1 or List 2, i.e., when either a exceeds m or b exceeds n. Assume that each list has at least one member. The algorithm steps are:

1. a=0, b=0—Set the counters for each list to an initial value of zero.
2. a = a+1 : b = b+1—Increment the list counters.
3. If a > m, then quit—If a exceeds m, then there are no more members of L_x.
4. If b > n, then quit—If b exceeds n, then there are no more members of L_y.
5. Read X_a : Read Y_b—Read the next member of each list.
6. If $X_a = Y_b$, then go to step 16—A match. Add this value to the answer list.

(If step 6 fails, no match is found and either X_a or Y_b is larger than the other. After determining which list contains the smaller value, increment the counter for that list and read the next item in the list.)

7. If $X_a < Y_b$, then go to step 12—If true, then X_a is smaller, and the next member of L_x should be read.

(If step 7 is not true, then Y_b must be less than X_a. Therefore, increment b and read the next member of L_y.)

8. b = b+1—Increment the counter for L_y.
9. If b > n, then quit—If b exceeds n, then the entire list has been read.
10. Read Y_b—Read the b^{th} member of list L_y.
11. Go to step 6—Do comparison.
12. a = a+1—Increment the counter for list L_x.
13. If a > m, then quit—If a exceeds m, then the entire list has been read.
14. Read X_a—Read a^{th} member of list L_x.
15. Go to step 6—Do comparison.
16. Write the value X_a in answer list—Update the answer list. Either X_a or Y_b can be chosen since they are equal. (No discussion of the manner in which answer list is maintained is presented here.)
17. Go to step 2—Get the next list members.

Notice that each list member is examined one time and that the answer list is always ordered.

This algorithm performs set intersection. A similar algorithm can be devised to do set union. The intersection of two sets is the set that contains items common to both sets. The union of two sets is the set of items contained in one, the other, or both lists.

Notice that a single step in the algorithm—step 6—compares the two values in each list. The remainder of the algorithm is bookkeeping—testing for the end of lists and determining which list counter, a or b, should be incremented. Another method of comparison using bitmaps affords the opportunity to use machine-language instructions to find the intersection and union of two ordered lists.

Bitmaps

A bitmap is a string of 1s and 0s. Each member of the bitmap has a position and a value, and each position in the bitmap can take on the value 0 or 1. A bitmap of length 8 (a byte of memory) can represent any ordered list of the integers 0 through 7. A value of 1 in a bitmap position means that the integer corresponding to that position is included in the list; a 0 in that position means that the integer is not included in the ordered list. The bitmap 10001001 thus stands for the ordered list (0, 4, 7) (see table 1). Table 2 provides some other examples.

A single byte can be used to represent an ordered list of from 0 to 8 elements in the range of integers 0 to 7. Thus, the ordered lists ( ) and (0, 1, 2, 3, 4, 5, 6, 7) can be represented by a single byte, as table 2 shows.

In some cases, bitmaps may represent a memory savings over alternative methods of representing an ordered list. I will have more to say about such memory requirements when I discuss compression of bitmaps.

Bitmaps for Comparisons

Bitmaps provide an elegant method for comparing ordered lists. This method relies on the powerful AND and OR Boolean operations found in most machine languages. The results of the AND operation on 2 bits equals 0 unless both bits are 1, and the result of the OR operation on 2 bits equals 1 unless both bits are 0. Table 3 shows the AND and OR operations performed on bitmap representations of the two lists (0, 2, 5, 7) and (1, 3, 5, 6).

If you are unfamiliar with Boolean operations, look closely at table 3. A bit-by-bit operation has been performed vertically. Notice that the results are ordered lists. Hundreds of machine cycles would have been required to solve these problems using a standard algorithm. (For example, try using the 17-step comparison algorithm to find the intersection of the two lists in table 3, keeping track of the number of increments and comparisons.) An assembly-language program to solve the same problems using bitmaps is much faster. If location A contains a bitmap representation of (0, 2, 5, 7) and location B contains a bitmap representation of (1, 3, 5, 6), then a two-step program performs the intersection:

```
LDA A
AND B
```

The first of these two statements loads the accumulator with the contents of A. The second statement performs an AND on the contents of the accumulator with the contents of memory location B. Only three machine cycles are required for each instruction, using a 6502 microprocessor. Eight machine cycles are

```
01234567←Position (0 through 7)
10001001←Value (0 or 1)
```

Table 1: *The bitmap 10001001, which represents the ordered list (0, 4, 7).*

Bitmap	List
00010001	(3, 7)
11100001	(0, 1, 2, 7)
00111100	(2, 3, 4, 5)
00000000	( ) (List with no members)
11111111	(0, 1, 2, 3, 4, 5, 6, 7)

Table 2: *Bitmap examples and the corresponding lists.*

a. The intersection of two sets.

```
        Bitmap     List
        10100101←(0, 2, 5, 7)
Input     AND
        01010110←(1, 3, 5, 6)
            →
Result  00000100→(5)
```

b. The union of two sets.

```
        Bitmap     List
        10100101←(0, 2, 5, 7)
Input     OR
        01010110←(1, 3, 5, 6)
            ↓
Result  11110111→(0, 1, 2, 3, 5, 6, 7)
```

Table 3: *Boolean operations on the bitmap representations of two lists: (0, 2, 5, 7) and (1, 3, 5, 6). The bit-by-bit AND operation (a) yields a bit representing the intersection of the sets of elements in the two input lists; the OR operation (b) yields a bitmap representing the union of the two input lists.*

Listing 1: *The assembly-language code that performs the intersection of two 256-byte ordered lists.*

```
        LDX #0      Load the X register with 0.
LOOP    LDA A,X     Load the accumulator with the contents of address A
                    modified by register X. The actual address to be used is A
                    + the contents of the X register.
        AND B,X     Perform an AND on the contents of the accumulator with the
                    contents of the address B modified by register X.
        STA C,X     Store the result of the AND operation in the memory location
                    C modified by register X.
        INX         Increment the X register, i.e., add 1 to the existing contents
                    of the X register.
        CPX #0      Compare contents of X register with number 0. In the 6502,
                    a wraparound occurs when the value 255 is incremented, i.e.,
                    255 + 1 = 0.
        BNE LOOP    If the comparison of X with 0 is not equal to 0, then go to
                    LOOP.
```

Bitmap Position	Abbreviation	Attribute
0	SEX	0 = MALE 1 = FEMALE
1	MAR	0 = UNMARRIED 1 = MARRIED
2	TYP	0 = DOES NOT TYPE 1 = TYPES
3	COL	0 = NOT COLLEGE GRAD 1 = COLLEGE GRAD
4	FRN	0 = NOT FRENCH SPEAKING 1 = SPEAKS FRENCH
5	GER	0 = NOT GERMAN SPEAKING 1 = SPEAKS GERMAN
6	ITL	0 = NOT ITALIAN SPEAKING 1 = SPEAKS ITALIAN
7	RUS	0 = NOT RUSSIAN SPEAKING 1 = SPEAKS RUSSIAN

Table 4: *The bitmap representation of an employee file.*

Bitmap Abbreviation→	SEX	MAR	TYP	COL	FRN	GER	ITL	RUS
Employee 1	0	0	1	1	1	1	0	0
Employee 2	1	1	1	0	0	0	0	1
Employee 3	1	1	0	1	1	0	1	1
Employee 4	0	0	1	1	0	1	1	0
Employee 5	1	1	0	0	1	1	0	1

Table 5: *The bitmap construction for a personnel file. The abbreviations are defined in table 4.*

needed to compare bitmaps as opposed to hundreds of machine cycles required to compare ordered lists represented in some other fashion.

A bitmap of length 8 is not a particularly exciting data structure because it is limited to the integers 0 to 7. However, by using a page of memory (256 bytes × 8 bits/byte = 2048 bits), we can use bitmaps to represent ordered lists for the integers 0 to 2047. Here we see the possibilities for a much more powerful data structure.

In extending our single-byte example for intersection, we will use two ordered lists of 256 bytes. The first list begins at location A and the second at location B. We wish to store the intersection beginning at location C. The assembly-language code in listing 1 performs the intersection for A and B.

The union operation is analogous. Merely replace the instruction AND B,X with ORA B,X (perform an OR on the contents of the accumulator with the contents of location B modified by register X).

Use of Bitmaps

Perhaps the most familiar use of bitmaps in home microcomputers is in the disk operating system (DOS), in which each sector on a disk is given a particular position in a bitmap. The use of a 1 in that place means that the sector is free and able to be used for a new file. The use of a 0 in that place means that the sector has been used and is unavailable for a new file. In the DOS application, there are only two possible values for a sector, either used or unused—a binary attribute.

A particular database may contain several binary attributes that can be handled with bitmap representations. Take, for example, a personnel file for a corporation that has extensive European operations. Table 4 illustrates the bitmap representation of such a file, and table 5 details the file's construction for five employees.

Based on the table 5 data, employee 1 is an unmarried male with a college degree who can type and who speaks French and German but not Italian or Russian. Employee 2 is a married female without a college degree who can type and who speaks Russian but not French, German, or Italian. Employee 3 is a married female with a college degree who does not type and who speaks French, Italian, and Russian but not German.

Notice that the table 5 structure is a matrix. The characteristics for an employee are stored horizontally. The vertical representation is also interesting. Looking down the Typist column, note that employees 1, 2, and 4 can type. Also notice that employees 2, 3, and 5 speak Russian, and so on. The columns are examples of inverted lists. The inverted lists in the personnel file enable the manager to easily find employees who have certain skills.

Because the columns of the matrix form a bitmap, the AND and OR operations can be used on the col-

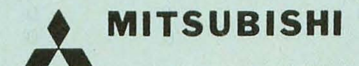
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3	1	AND	1	→	1	AND	1	→	1
4	0		0		0		1		0
5	1		1		1		0		0

Table 6: *The intersection of RUS, SEX, and COL columns of the table 5 bitmap construction. The answer indicates that only employee 3 is female, Russian-speaking, and a college graduate.*

umn representations. For example, a female Russian-speaking college graduate can be found by performing the following intersection: RUS AND SEX AND COL. The intersections are done serially, as table 6 shows. First, the intersection of RUS and SEX is performed, then the resulting intersection answer is intersected with COL.

In the personnel-file example, a single bit represents the presence or absence of an attribute. This scheme may result in space saving when you're constructing a database because you can use a single bit in place of an entire field within a record. The bitmap scheme also provides a time-saving method for retrieving records that match search criteria.

Extending Bitmaps to More Complex Systems

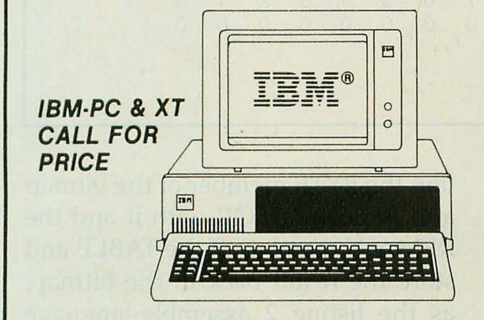
Bitmaps easily lend themselves to cross-indexing systems for literature. The LITMAS system, for example, creates a matrix similar to that presented for the personnel problem of the previous section. Instead of indexing (or characterizing) employees, LITMAS characterizes an item such as a journal article, a client, or a 35mm slide. The attributes used for indexing are called keywords. LITMAS permits the definition of 512 items per disk (analogous to employees in the previous example) and 512 keywords (analogous to the column headings: SEX, COL, TYP). Any number of keywords may be attributed to an item. The power of bitmap searches becomes very evident in LITMAS, which can perform 60 intersections or unions on a file of 512 items in less than 20 seconds.

The examples discussed in the remainder of this article use a bitmap matrix of length 256. Although smaller than the LITMAS matrix, this matrix can demonstrate bitmap calculations while allowing a single byte to represent a position number. In extending our discussion to larger matrices, we will have the opportunity to discuss the techniques for modifying and compressing a bitmap.

The rows in our matrix are bitmaps

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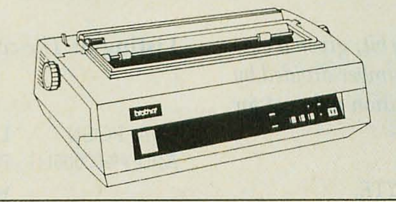
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Position	0 1 2 3 4 5 6 7	8 9 10 11 12 13 14 15	16 ... 247	248 249 250 251 252 253 254 255
Byte #	Byte 0	Byte 1	...	Byte 31
Bit # in Byte	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	7 ... 0	7 6 5 4 3 2 1 0
Bit Value	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0	0 ... 0	0 0 0 0 0 0 0 0

Table 7: *Bitmap representation of items prior to indexing.*

of length 256; that is, positions 0 to 255 are represented. This representation requires 32 bytes (32 bytes × 8 bits/byte = 256 positions). Within LITMAS, each position in a bitmap row is associated with a user-defined keyword. Keyword number 0 is in position 0 of the bitmap; keyword number 1 is in position 1 of the bitmap, and so on. As a new item is indexed, the appropriate keyword positions are set from 0 to 1. Table 7 shows the bitmap representation before indexing.

The top row of table 7 specifies the position within the bitmap, 0 to 255, and the second row demonstrates the byte numbers corresponding to various bitmap positions. Byte 0 contains positions 0 through 7, while byte 1 contains positions 8 through 15, and so on. The third row shows the bit position within the byte. The high-order bit is 7 and the low-order bit is 0. The fourth row specifies a value of 0 in the bitmap row prior to indexing any item.

In order to flip a bit from 0 to 1 at a particular position in the bitmap, it is necessary to locate the specific bit by tracing from position number to byte number and then to bit number within that byte.

Beginning with a bitmap of all 0s, it is necessary to change the 0s to 1s in those positions corresponding to the attributes to be associated with the item. Suppose a bitmap-position integer corresponding to such an attribute is contained in the POSN location. To determine the bit to be changed, you must determine the BYTE number and the BIT number within that BYTE. To find the BYTE and BIT numbers, divide POSN by 8. The integer result of this division, i.e., BYTE = INTEGER (POSN/8), is the byte position in the bitmap. The remainder from the division, REMAIN = POSN – (8*BYTE), can be used with listing 2 and its code, which employs an OR operation to set the appropriate bit to 1.

To perform the operation, we can load the Y register with BYTE and the X register with REMAIN. We then obtain the BYTE member of the bitmap and perform an OR with it and the REMAIN member of the TABLE and store the result back in the bitmap, as the listing 2 assembly-language code shows. The OR operation sets the desired bit to 1 while other bits within the byte retain their previous values.

In our calculation of BYTE and REMAIN we used quasi-BASIC code. In assembly language there is a quick way to determine the BYTE and REMAIN values. Because POSN is a single-byte integer, integer division by 2 is a right shift of the number, and division by 8 is three right shifts. The remainder, REMAIN, is the value of the 3 low-order bits of POSN, while the 5 high-order bits of POSN contain INTEGER.

Our calculations thus become easy in assembly language, as listing 3 illustrates.

Sparse Matrix Problem

It is clear that bitmaps are efficient for representing ordered lists when

Listing 2: *A method for setting a particular bitmap bit, given a byte number (the integer portion of a bitmap-position number divided by 8) and a remainder. (The table indicates the bit position to be set for a given remainder.)*

```
LDY BYTE       Load Y register with the value BYTE.
LDX REMAIN     Load X register with the value
               REMAIN.
LDA BITMAP,Y   Load accumulator with contents of the
               address bitmap modified by the Y
               register.
ORA TABLE,X    Perform an OR on the accumulator with
               the contents of TABLE modified by X
               register.
STA BITMAP,Y   Store the accumulator (result) back into
               the BITMAP.

TABLE—1000 0000  Remainder 0 sets 7th bit
      0100 0000  Remainder 1 sets 6th bit
      0010 0000  Remainder 2 sets 5th bit
      0001 0000  Remainder 3 sets 4th bit
      0000 1000  Remainder 4 sets 3rd bit
      0000 0100  Remainder 5 sets 2nd bit
      0000 0010  Remainder 6 sets 1st bit
      0000 0001  Remainder 7 sets 0th bit
```

Listing 3: *The code for the calculation of BYTE and REMAIN.*

```
LDA POSN          Load the accumulator with POSN.
AND #%00000111    Perform an AND on the accumulator
                  with the binary value 00000111. The
                  result of this operation will be to zero
                  out bits 7, 6, 5, 4, and 3. Bits 2, 1, and
                  0 remain as they were.
STA REMAIN        Store the result in REMAIN.
LDA POSN          Load the accumulator with POSN.
LSR               Shift the accumulator to the right (LSR
                  = logical shift right one bit) three
                  times and ignore the bits which fall out.
                  (Note that each LSR pushes a 0 into the
                  high-order bit.
LSR
LSR
STA BYTE          Store the result of the shifts in BYTE.
```



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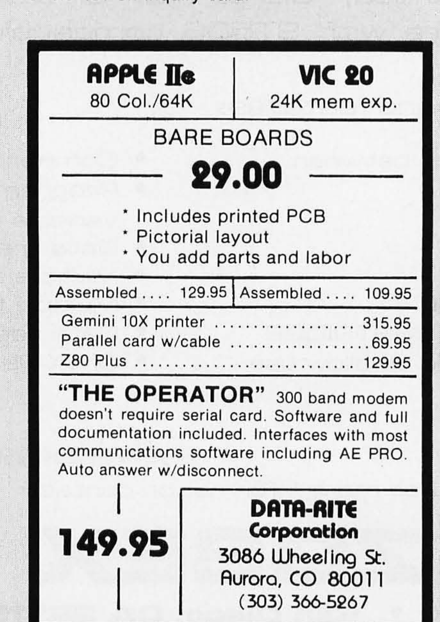


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the number of 1s in the list is almost equal to the number of 0s. If there are 100 bits set to 1 and 156 bits set to 0, a bitmap of 32 bytes can be used to represent a list containing 100 integers. As the number of 1s in the bitmap declines toward 0, however, the efficiency of the bitmap for memory use declines proportionately. This is the sparse matrix problem that occurs when a matrix is filled with a great many more 0s than 1s.

Suppose a bitmap of length 256 is used to represent the ordered list (1, 254). The bitmap still requires 32 bytes. Because a single byte of memory can be used to represent any number from 0 to 255, you could use 2 bytes of memory to represent the two integers in the ordered list, a savings of 30 bytes over the bitmap method.

In designing LITMAS files I confronted a similar problem. I estimated that of 512 possible keywords, an average of 10 to 20 would be used for any particular item. I considered using lists in integer form and converting to bitmaps prior to list comparisons. The same routine used to update a bitmap can be used to convert an integer list to a bitmap. In such a case, the bitmap becomes an intermediate form of representation that still permits rapid manipulation of lists.

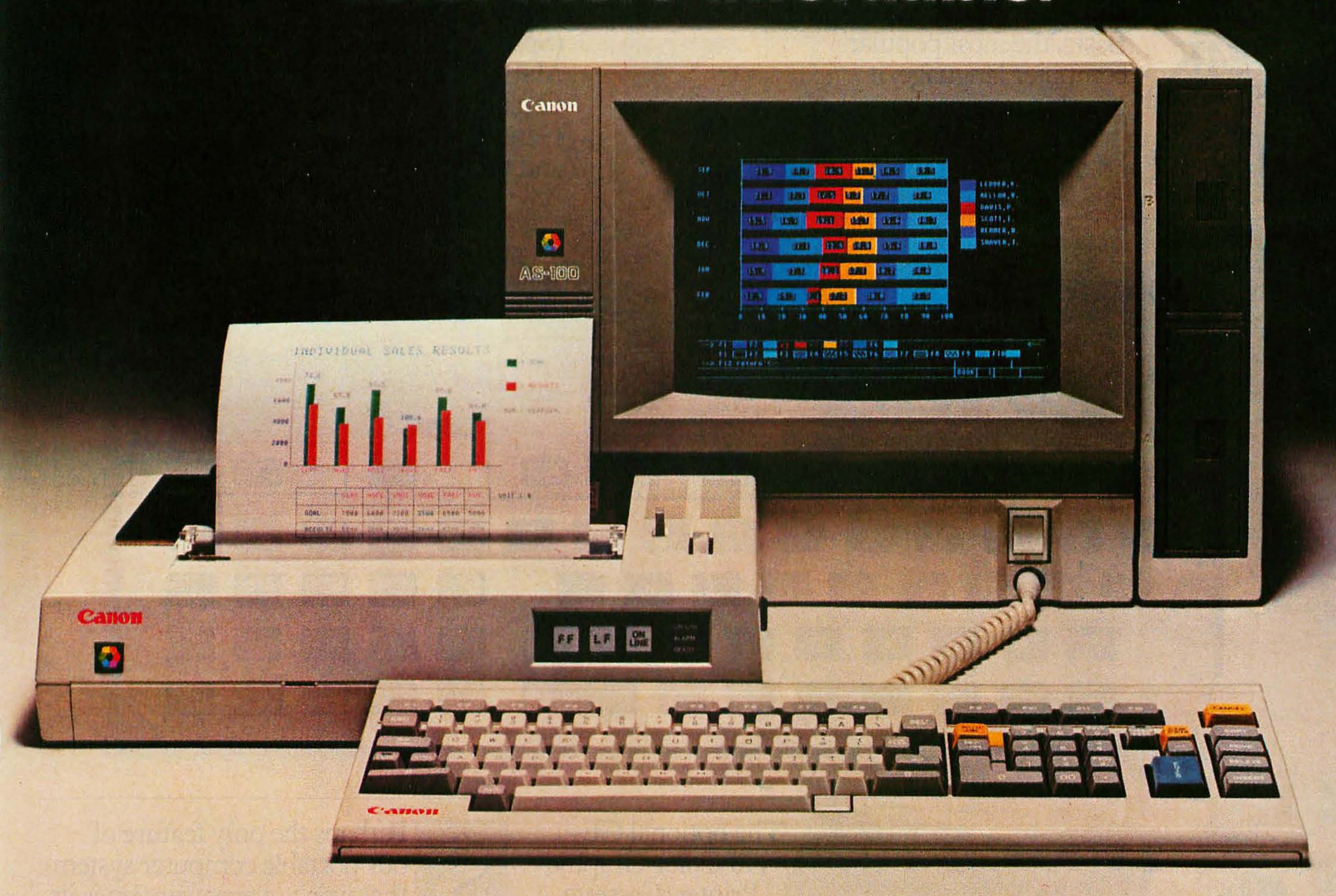
In the design of LITMAS, however, I took another approach and developed a series of algorithms for the compression and expansion of bitmaps. A visual image of the files is that of an accordion. When the bellows is completely expanded, the files are ready for AND and OR operations. However, the bellows are stored on disk in a compressed format that guarantees that no bytes are 0 unless the entire bitmap is 0. In this last case, only a single byte is required.

Bitmap Compression

The manner in which compression is accomplished is best illustrated with an example and a series of diagrams. Then I will explain the coding tricks used to accomplish the compression.

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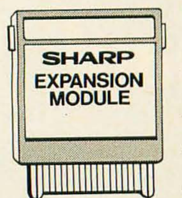
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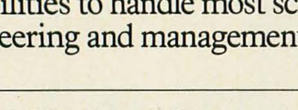
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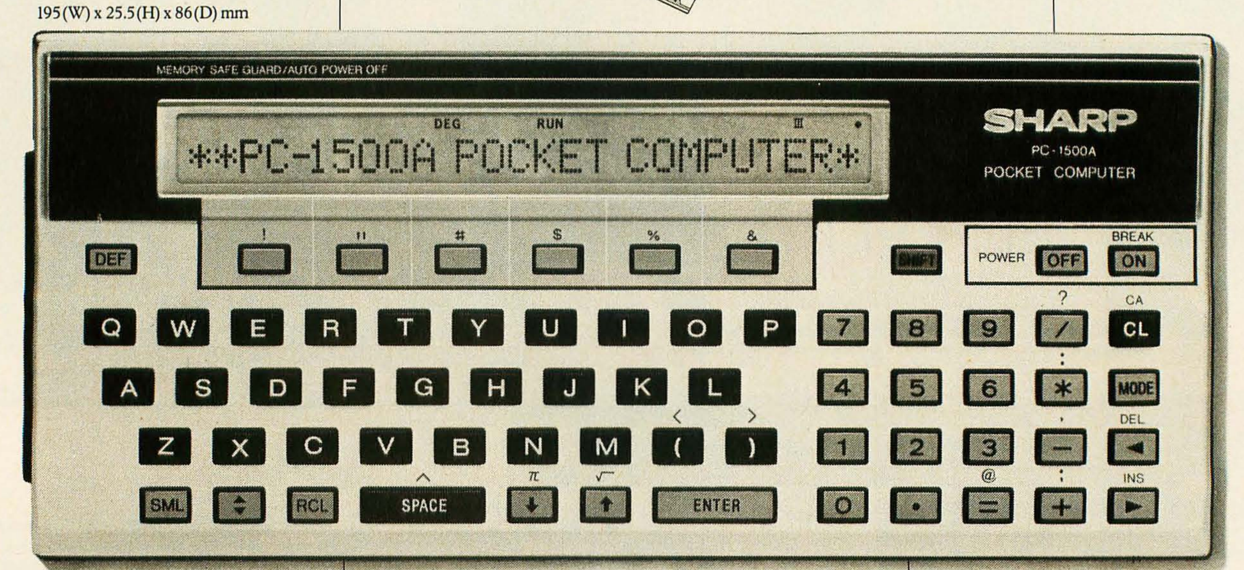
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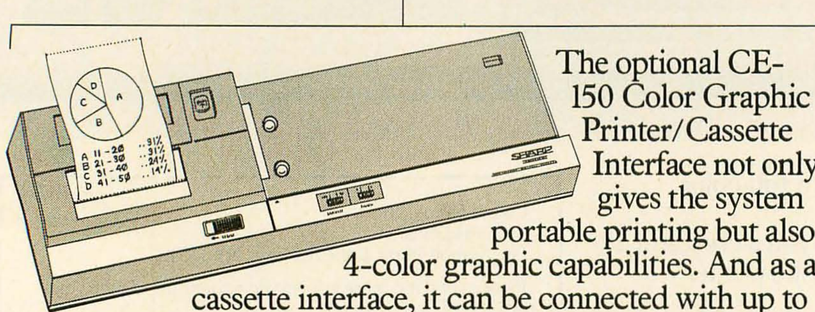




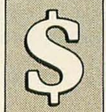
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Value	0	0	1	0	...	0	1	0	...	0	1	0	...	0	1

Table 8: *Bitmap representation of the list (2, 16, 128, 255). Only 4 bits out of 256 are nonzero.*

Original Bitmap	Representation	Compression Value =1 if byte not 0
Byte 0	0 0 1 0 0 0 0 0	1
Byte 1	0 0 0 0 0 0 0 0	0
Byte 2	1 0 0 0 0 0 0 0	1
Byte 3	0 0 0 0 0 0 0 0	0
Byte 4	0 0 0 0 0 0 0 0	0
Byte 5	0 0 0 0 0 0 0 0	0
Byte 6	0 0 0 0 0 0 0 0	0
Byte 7	0 0 0 0 0 0 0 0	0
Byte 8	0 0 0 0 0 0 0 0	0
Byte 9	0 0 0 0 0 0 0 0	0
Byte 10	0 0 0 0 0 0 0 0	0
Byte 11	0 0 0 0 0 0 0 0	0
Byte 12	0 0 0 0 0 0 0 0	0
Byte 13	0 0 0 0 0 0 0 0	0
Byte 14	0 0 0 0 0 0 0 0	0
Byte 15	0 0 0 0 0 0 0 0	0
Byte 16	1 0 0 0 0 0 0 0	1
Byte 17–23	0 0 0 0 0 0 0 0	0
Byte 24–30	0 0 0 0 0 0 0 0	0
Byte 31	0 0 0 0 0 0 0 1	1

Table 9: *The original bitmap representation of the list (2, 16, 128, 255), arranged as four groups of 8 bytes each, plus the compression value for each byte.*

Table 8 shows a bitmap of length 256 representing the ordered list (2, 16, 128, 255). Only 4 bits in the map are set to 1, meaning that there are 252 0s. Almost all the bytes in the 32-byte bitmap are 0 (see table 9). The exceptions are easily calculated from our previous discussion. Note that table 9 includes a compression column. Look at each byte in the 32-byte bitmap. If that byte contains any nonzero bits, we place the value 1 in the compression column. If that byte in the original bitmap contains all 0 bits, we place the value 0 in the compression column. Notice also that the bytes are broken up into groups of 8. Bytes 0 to 7 are grouped together, then 8 to 15, 16 to 23, and 24 to 31. Now, look at the compression values, written as a single row and arranged in four groups corresponding to the four groups of bytes in table 9:

1. 10100000
2. 00000000
3. 10000000
4. 00000001

To optimize the compression, retain only the nonzero bytes from the original bitmap. Note that the compression values fit neatly into 4 bytes, with every bit representing a corresponding byte in the original bitmap. All zero values in a byte of the original bitmap are represented by a single 0 bit in the compression. By using a single 0 byte for a byte of 0, there is considerable memory savings.

I elected to call the original, noncompressed bitmap a zero-order bitmap. Each bit in a zero-order bitmap stands for its corresponding integer in an ordered list. A first-order bitmap is a single compression of a zero-order bitmap. The compression scheme has been used a single time. There is no need to stop at a first-order bitmap; the compression can continue to other levels. Thus, a second-order bitmap is a doubly compressed structure, a third-order bitmap a trebly compressed structure, and so on.

To return to our example, the first-order bitmap is merely the linear string of compression values, bit 0 representing the zeroth byte of the original map, bit 1 representing the first byte of the original, bit 2 representing the second byte, and so on. In our example, the first-order bitmap is a string of 4 bytes.

Our resulting shorthand representation of the original bitmap for the (2, 16, 128, 255) list is merely the 4-byte first-order map (the compression values) together with the four nonzero bytes (bytes 0, 2, 16, and 31) of the original map.

As a result of the compression, our 32-byte original map has been reduced to 8 bytes. Within LITMAS we do not use any termination symbol between the first-order map and the original nonzero bytes. When multiple compressions are used, it is necessary to identify the number of compressions and the length of the highest-order compression. Within LITMAS, we frequently use a second-order bitmap, which looks as follows:

SECOND-ORDER MAP + NONZERO MEMBERS FIRST-ORDER MAP + NONZERO MEMBERS OF ORIGINAL MAP.

The second-order map is used to expand the first-order map, which is then used to expand the zero-order map.

A Compression Algorithm

Compression may appear difficult, but machine-language instructions come to our assistance. One useful instruction is ROL (rotate 1 bit left for memory or accumulator), illustrated here:

C←7←6←5←4←3←2←1←0←C,

where C is the carry bit and the

numbers 0 to 7 represent bit positions within the memory or accumulator; 0 is the low-order bit and 7 is the high-order one. Note that the contents of the carry are shifted into the low-order bit while each bit shifts left one position. The high-order bit drops out into the carry.

It is possible to set or clear the carry bit and load the result into the low-order position. Following the instruction, it is possible to test the carry bit and determine the contents of the high-order position prior to the ROL, i.e., the previous high-order bit lands in the carry bit at the completion of the instruction.

Because the carry bit is easily tested following the ROL operation, the ROL is very useful for counting to 8. To do so, first load a memory location, M, with 1 and set the carry initially to 0. Then, perform eight consecutive ROL operations. After the eighth ROL operation, the carry goes to 1, a condition that is immediately testable in a two-cycle operation.

Listing 4 is the 6502 assembly-language algorithm for accomplishing a compression of a 32-byte bitmap. The original bitmap begins at location BITMAP, and the first-order compression bitmap is to be calculated and stored beginning at memory location FIRST. The memory location ROLBYT is used as a counter to 8 and also as the value to be placed in the first-order compression. The X index register is used as a counter for indexed addressing of BITMAP, and the Y index register is used as a counter for indexed addressing of FIRST.

Listing 4: *The 6502 assembly-language code for compressing a 32-byte bitmap.*

```
        LDX #0          Initialize X and Y to 0.
        LDY #0
        LDA #1          Load accumulator with number 1.
        STA ROLBYT      Store accumulator (1) in ROLBYT.
LOOP    CLC             Clear carry. Set carry = 0.
        LDA BITMAP,X    Load acummulator with location BIT-
                        MAP modified by X.
        BEQ LOOP1       If the original bitmap byte equals 0,
                        branch immediately to ROL instruction.
        SEC             Set carry. Set carry = 1. We arrive at
                        this instruction if BITMAP,X is not 0. In
                        this case we wish to put a 1 in the
                        carry bit prior to executing the ROL.
LOOP1   ROL ROLBYT      The carry bit is placed in the low-order
                        position of ROLBYT while other posi-
                        tions in ROLBYT are shifted left. The
                        previous high-order position of ROLBYT
                        falls into carry for testing.
        BCC BUMPX       Branch on carry clear to BUMPX. If the
                        carry bit is 0, the count is less than 8.
                        If carry is set, the count is equal to 8
                        and it is time to store ROLBYT in
                        FIRST.
        LDA ROLBYT      Load accumulator with ROLBYT.
        STA FIRST,Y     Store accumulator (ROLBYT) in FIRST
                        modified by Y register value.
        INY             Increment Y register. Y = Y + 1. In
                        order to point to the next position in
                        FIRST.
        LDA #1          Load accumulator with 1 and
                        reinitialize ROLBYT.
        STA ROLBYT
BUMPX   INX             Increment X register. X = X + 1. To
                        point to next value in BITMAP.
        CPX #32         Compare X to 32. If X equals 32 than
                        positions BITMAP + 0 to BITMAP +
                        31 have been completely processed.
        BNE LOOP        If X is unequal to #32 then continue
                        looping.
                        If X = 32 then fall out of the loop. The
                        next routine is more difficult. You must
                        guarantee that the last value in the first
                        order map is left adjusted. Eight shifts
                        of ROLBYT are required in order to
                        maintain the correct order within the
                        first-order map.
        LDA ROLBYT      Load accumulator with ROLBYT.
        CMP #1          Compare accumulator (ROLBYT) with
                        1. If ROLBYT equals 1 then Y has just
                        been incremented and the original bit-
                        map was a multiple of 8 and you are
                        done.
        BEQ DOREST      If accumulator (ROLBYT) was equal to
                        1, then you are done with compression.
                        You are ready to read the original bit-
                        map and pick up the nonzero members.
                        If ROLBYT was not equal to 1, then
                        ROLBYT must be shifted to the left as
                        many times as necessary until the carry
                        is equal to 1.
```

Listing 4 continued on page 494

Bitmap Expansion

In order to expand a compressed bitmap, you need to know both the order of the compression (number of compressions) and the length of the highest-order expression. In the previous section we were left with a compression of 4 bytes to which the nonzero members of the original bitmap are appended, as follows: FIRST-ORDER COMPRESSION + NONZERO BYTES FROM ORIGINAL BITMAP.

This expression is stored beginning at location FIRST. The length of the total expression is relatively unimportant. The critical pieces of information are the length of the COMPRESSION as well as the ORDER of the compression. We restrict ourselves to the case of FIRST-ORDER compressions. The length of the compression is stored in a location, LENGTH. The reconstruction of the original map is stored in contiguous memory locations beginning at BITMAP.

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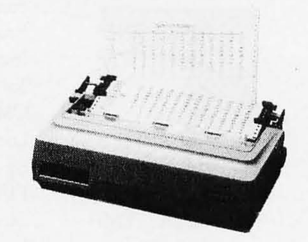
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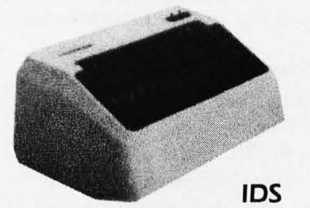


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Listing 4 continued:

```
         CLC           Clear carry. Prepare to zero out the
                       low-order bits of ROLBYT.
LAST     ROL           Accumulator contains ROLBYT. ROL
                       the accumulator.
         BCC LAST      Branch on carry clear (carry = 0) to
                       LAST. Loop continues until carry is set.
         STA FIRST,Y   Now store the left adjusted accumulator
                       in FIRST modified by Y register.
         INY           Increment the Y register to point 1
                       location past the end of the first-order
                       map.
DOREST   LDX #0        When DOREST is reached, the first-
                       order map has been constructed and
                       placed in Y consecutive locations
                       beginning at FIRST. Set up X register
                       to read original bitmap. Y is already
                       pointing to one position past the end of
                       the compression that begins at FIRST.
LOOP2    LDA BITMAP,X  Read the next member of original
                       bitmap.
         BEQ BUMPXX    If the byte from the original is 0, it is
                       ignored. If not equal to 0, it is added to
                       the end of FIRST.
         STA FIRST,Y   Store the nonzero byte in next location
                       in FIRST.
         INY           Increment Y to point to the next byte in
                       FIRST.
BUMPXX   INX           Increment X.
         CPX #32       Compare X to 32. If X equals 32, the
                       original bitmap has been completely
                       read.
         BNE LOOP2     If X is less than 32, return to LOOP2
                       and read the next member of the
                       original bitmap.
```

Listing 5: *The 6502 code for expansion of a first-order map.*

```
         LDA #0        Load accumulator with 0.
         STA FCTR      Store accumulator in FCTR. The
                       pointer into FIRST is set to 0.
         TAY           Transfer accumulator to Y register.
                       Zeroes Y register, the pointer into
                       BITMAP.
         LDA LENGTH    Load accumulator with LENGTH. The
                       nonzero members of the original bitmap
                       are stored beginning at FIRST +
                       LENGTH.
         STA NZCTR
```

Memory map at beginning of processing for the compressed expression:

```
FIRST-ORDER COMPRESSION ... NONZERO BYTES OF ORIGINAL
↑
FCTR                                NZCTR = FIRST + LENGTH
```

```
CMPRES   LDX FCTR      Load X register with contents of FCTR.
                       Setting up to read next member of the
                       first-order compression.
         CPX LENGTH    Compare X with value of LENGTH.
                       When X = LENGTH, processing is
                       complete.
         BEQ END       Branch on Equal to END.
         INC FCTR      Increment FCTR. FCTR = FCTR + 1.
                       To set up counter for next pass through
                       CMPRES loop.
         LDA FIRST,X   Load accumulator with FIRST modified
                       by X register. Gets next byte from
                       FIRST.
         STA TEMP      Store accumulator in TEMP. TEMP is a
                       location that will be used to process the
                       compression.
         LDA #1        Load accumulator with 1.
         STA ROLBYT    Store accumulator (1) in ROLBYT.
                       ROLBYT will be used to count to 8.
LOOP     LDA #0        Load accumulator with 0. To be used
                       for insertion into bitmap in case where
                       compression bit is equal to 0.
         ROL TEMP      Rotate Left TEMP. Pushes high-order bit
                       into carry for testing.
         BCC STORE     Branch on carry clear to store. If carry
                       = 0 then 0 (in accumulator) should be
                       placed in BITMAP. If carry = 1 then
                       we read the next nonzero byte from the
                       original bitmap.
         LDX NZCTR     Load X with NZCTR. Set up X register
                       with current pointer for nonzero
                       members of original bitmap.
         INC NZCTR     Increment NZCTR. Set up NZCTR for
                       next iteration.
         LDA FIRST,X   Load accumulator with contents of
                       FIRST modified by X.
STORE    STA BITMAP,Y  Store accumulator in location BITMAP
                       modified by Y register.
         INY           Increment Y to set up for next STORE.
         ROL ROLBYT    Process the counter ROLBYT.
         BCC LOOP      Branch on carry clear to LOOP. Carry
                       will be clear until eighth iteration.
         BCS CMPRES    Branch on carry set to CMPRES. After
                       the eighth iteration, must set up next
                       byte of compression and reset ROLBYT.
END      ...           Arrive here when FCTR equals
                       LENGTH.
```

1. FCTR is the counter into the FIRST-ORDER COMPRESSION.
2. NZCTR is the counter into the NONZERO BYTES.
3. Y register is a counter into BITMAP.

Because the 6502 has only two index registers, we have to use our counter locations to set the index registers.

We have elected to use the X register for the FIRST-ORDER COMPRESSION and for the NONZERO BYTES of the original map. Listing 5 provides the 6502 code for expansion of a first-order map.

Summary

Bitmaps are an efficient data representation for performing set operations on ordered lists. The binary nature of the file allows the programmer direct use of the AND and OR functions. In some cases, bitmaps may also represent an optimal notation for an ordered list.

As the sparseness (number of 0s compared to 1s) of the bitmap increases, the efficiency of the bitmap for data encoding is compromised. Our compression technique may solve this problem for some applications.■

Eric Sohr, MD, is chairman of the Department of Family Practice at Saint Vincent Hospital, Billings, Montana. He received his MD at the University of Maryland in 1969 and has spent the last four years designing the LITMAS system. He can be reached in care of LITMAS, Worden, MT 59088.

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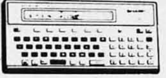
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Simplified Program Interfacing

By using jump and data tables, this technique overcomes the drawbacks of traditional methods of interfacing programs

by Raymond F. Irvine

You can employ a programming technique based on jump and data tables to simplify the interface between two programs when at least one of them has fixed entry points and data addresses. Most of the example programs presented here are written in BASIC and execute USER calls to assembly-language subroutines. Although these programs use Microsoft BASIC and Z80 mnemonics, you can easily adapt the technique to other languages or processors. The versions presented should suit the needs of both cassette and disk users.

The Standard Interface

The most obvious, hence most common, technique programmers use to interface a BASIC program to assembly-language subroutines is shown in listing 1. The BASIC program calls each assembly-language subroutine directly at the location at which the routine resides in memory. Typically, data is passed between programs using BASIC PEEKs and POKEs to data areas located somewhere within or following the subroutine that uses the data. This common technique produces functional programs; however, it is cumbersome to use during the development and debugging process. Usually, any change to an assembly-language routine results in the shifting of addresses following the change. This shift, in turn, frequently affects BASIC entry points and data-transfer locations.

Listing 2 demonstrates how adding only one line of assembly-language code can force several changes to a BASIC program. This need to modify the program can be a nuisance, especially to cassette users who do not have the option of using hexadecimal notation in BASIC and must convert each address to decimal form. Because the typical process of testing and debugging a program results in several such iterations, any means of reducing the impact of assembly-language changes on the BASIC interface makes the overall task much easier for the programmer.

The standard technique is inefficient because the programmer is making direct calls to routines that are embedded within code that is subject to frequent changes. This situation is similar to the one that confronts a programmer who assembles his programs by hand or who uses a simple assembler that does not recognize labels. Each time he changes some code, he must update addresses throughout his program to compensate for his changes. The use of such direct references to address locations forces the programmer to assume this time-consuming chore. On the other hand, an assembler that allows use of labels permits a programmer to concentrate on his program and to use labels that indirectly refer to memory locations; the assembler itself keeps track of the addresses. Although the technique presented here doesn't provide labels that can be recognized by both BASIC and the assembler, it does make use of a form of indirect addressing that lets the assembler do most of the work to virtually eliminate the impact of assembly-language changes on a BASIC program.

Jump and Data Tables

The BASIC/assembly-language interface can be improved by restructuring the assembly-language program with the addition of a jump table and by consolidating all address locations used to pass data between

programs into one data table. These two tables are placed prior to any of the assembly-language routines to protect their locations from being arbitrarily moved as the assembly-language routines are altered. All BASIC PEEKs, POKEs, and USER calls are then directed through these tables. Listing 3 demonstrates how to implement the tables in the assembly-language program and how they should be accessed from BASIC.

The jump table becomes the first part of the assembly-language program. This table consists of a series of jump instructions directing program flow from the entry points to the actual routines to be accessed from BASIC. When the BASIC program initiates a USER call to an assembly-language subroutine, program execution transfers to the jump table. Because the assembler automatically updates the destination addresses of these jumps, a set of entry points has been established that does not change regardless of how many times the actual locations of the subroutines are shifted.

All data locations that are to be accessed by BASIC PEEKs and POKEs should be placed immediately following the jump table. By placing these data locations before the assembly-language routines, the data table has also been protected from any changes made to the routines. If it becomes necessary to add new locations to the table, they should be placed after the existing entries in order to preserve the existing locations of the addresses.

If you want to add new routines to an assembly program, make sure you've reserved space in advance by extending the jump table with spare entries pointing to either dummy addresses or a return instruction. For instance, a jump table for a BASIC interface can be created with 10 entries, one to correspond with each of BASIC's USER0(X) through USER9(X) call instructions.

Listing 4 shows the assembly program with jump and data tables after one line of code was added to a routine. While all addresses after the new line were changed, the BASIC interface through the jump and data tables remains the same.

We have now defined a structure for assembly programs that virtually eliminates the need to change BASIC USER calls, PEEKs, or POKEs in order to accommodate modifications made to assembly-language routines. This technique also makes it easier to define the BASIC/assembly-language interface in advance, producing the additional benefit of reducing the effort required before concurrent development of BASIC and assembly-language programs can begin.

More USER Calls

Jump tables are most effective when the BASIC interpreter is capable of making multiple USER calls. Most cassette BASICs provide only one USER call, and in some cases even the 10 USER calls of disk BASIC are not sufficient. Listing 5 presents a method of using a data location as an index to expand the number of USER calls available from BASIC to 255, when a 1-byte index is used.

To use the CLCINX routine (see listing 5), define the first entry point (ENTRY0) as the index routine and define the first (or only) USER call at this entry point. Then POKE the index location (INDEX) with the number of the desired routine (1 to 255). This number is determined by its order in the jump table, with the first jump (to CLCINX) being number zero. When the USER call is executed, the CLCINX routine calculates the proper entry point into the table and transfers execution to that address.

The CLCINX routine works by taking the number stored in INDEX and using it to form an offset to determine the appropriate jump-table entry point. This routine first checks that the index number is not zero. If zero were allowed, an endless loop would occur because the routine would repeatedly access itself. After this test, the number is tripled because each jump instruction is 3 bytes long. This result is then added to the address of the first jump instruction (ENTRY0) so that the HL register pair holds the address of the desired jump-table entry. Program control is then transferred to this address.

Assembly/Assembly Interfacing

The examples and descriptions presented so far in this article have dealt with the technique of interfacing BASIC programs to assembly-language subroutines; however, jump tables are also very useful when you're interfacing two or more assembly-language programs. One of the most common examples of this is in the implementation of the BIOS (basic input/output system) for Digital Research's CP/M.

The CP/M BIOS contains all the code required to configure the system to a specific hardware environment. By using a jump table (listing 6) to provide the interface with the standardized portion of the CP/M system, Digital Research significantly reduced the amount of effort otherwise required to implement CP/M on a specific system. This certainly has helped in establishing CP/M as a de facto standard for 8-bit microprocessor operating systems.

Another common use of jump tables is in monitor or bootstrap programs. Usually, the first entry point is accessed by a power-on jump or another absolute jump rather than a subroutine call. This allows the program to operate on a stand-alone basis. Routines within the program, such as console I/O, primitive disk I/O, or tape I/O, are made available as subroutines to other programs through the jump table.

Summary

The techniques presented in this article are relatively easy to apply and will relieve much of the frustration and busywork typically required when interfacing between two or more programs. The examples are simple and general enough for adaptation in most situations; however, you sacrifice a small amount of memory (30 bytes for a 10-entry jump table) and a few microseconds of additional time to execute the jump instruction.■

Raymond F. Irvine (646 Pearson Rd., Port Hueneme, CA 93041) works at the Vitro Laboratories Division of Automation Industries. He has studied at California State Polytechnic University at Pomona and California State University at Fullerton.

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Listing 1: *An assembly-language routine (a) and a BASIC program (b) showing the technique most programmers use to interface two such programs. Note that BASIC USER calls are made directly to RTNO (line 140 of the assembly-language code) and RTN1 (line 340).*

(a)

```
                00010 ;**********************************
                00020 ;**********************************
                00030 ;**   ASSEMBLY LANGUAGE SUBROUTINE  **
                00040 ;**     TO BE CALLED FROM BASIC     **
                00050 ;**********************************
                00060 ;**********************************
                00070 ;
F000            00080        ORG 0F000H      ;START AT F000H
                00090 ;
                00100 ;**********************************
                00110 ;*          ROUTINE 0             *
                00120 ;**********************************
                00130 ;
F000 3A23F0     00140 RTN0   LD A,(DATA1)    ;1ST ENTRY POINT
F003 0605       00150        LD B,05H        ;IGNORE CODE
                               .
                               .
                               .
F01F 3224F0     00240        LD (DATA2),A    ;SAVE ANSWER
F022 C9         00250        RET             ;RETURN TO BASIC
                00260 ;
F023 00         00270 DATA1  DEFB 00H        ;DATA FROM BASIC
F024 00         00280 DATA2  DEFB 00H        ;ANSWER FOR BASIC
                00290 ;
                00300 ;**********************************
                00310 ;*          ROUTINE 1             *
                00320 ;**********************************
                00330 ;
F025 3A43F0     00340 RTN1   LD A,(DATA3)    ;2ND ENTRY POINT
F028 CB27       00350        SLA A           ;IGNORE CODE
                               .
                               .
                               .
F03F 3244F0     00470        LD (DATA4),A    ;SAVE ANSWER
F042 C9         00480        RET             ;RETURN TO BASIC
                00490 ;
F043 00         00500 DATA3  DEFB 00H        ;DATA FROM BASIC
F044 00         00510 DATA4  DEFB 00H        ;ANSWER FOR BASIC
                00520 ;
0000            00530        END             ;END OF ROUTINES
```

(b)

```
10 REM ASSEMBLY PROGRAM ALREADY LOADED
20 REM BASIC MEMORY SIZE SET AT 0EFFFH
30 DEFUSR0 = &HF000: REM ENTRY POINT FOR ROUTINE 0
40 DEFUSR1 = &HF025: REM ENTRY POINT FOR ROUTINE 1
                         .
                         .
100 POKE &HF023,B: REM SEND DATA TO ROUTINE 0
110 A=USR0(X): REM EXECUTE ROUTINE 0
120 C=PEEK(&HF024): REM GET THE ANSWER
                         .
                         .
                         .
200 POKE &HF043,D: REM SEND DATA TO ROUTINE 1
210 A=USR1(X): REM EXECUTE ROUTINE 1
220 E=PEEK(&HF044): REM GET THE ANSWER
                         .
                         .
                         .
300 END
```

Listing 2: *An assembly-language listing (a) and a BASIC program (b) illustrating the impact of the addition of one line of assembly code (line 240). The affected addresses in the BASIC program are underlined.*

(a)

```
                00010 ;**********************************
                00020 ;**********************************
                00030 ;**   ASSEMBLY LANGUAGE SUBROUTINE  **
                00040 ;**     TO BE CALLED FROM BASIC     **
                00050 ;**********************************
                00060 ;**********************************
                00070 ;
F000            00080        ORG 0F000H      ;START AT F000H
                00090 ;
                00100 ;**********************************
                00110 ;*          ROUTINE 0             *
                00120 ;**********************************
                00130 ;
F000 3A25F0     00140 RTN0   LD A,(DATA1)    ;1ST ENTRY POINT
F003 0605       00150        LD B,05H        ;IGNORE CODE
                               .
                               .
                               .
F01F E67F       00240        AND 7FH         ;* ADD NEW CODE *
F021 3226F0     00250        LD (DATA2),A    ;SAVE ANSWER
F024 C9         00260        RET             ;RETURN TO BASIC
                00270 ;
F025 00         00280 DATA1  DEFB 00H        ;DATA FROM BASIC
F026 00         00290 DATA2  DEFB 00H        ;ANSWER FOR BASIC
                00300 ;
                00310 ;**********************************
                00320 ;*          ROUTINE 1             *
                00330 ;**********************************
                00340 ;
F027 3A45F0     00350 RTN1   LD A,(DATA3)    ;2ND ENTRY POINT
F02A CB27       00360        SLA A           ;IGNORE CODE
                               .
                               .
```

Listing 2a continued on page 504

Listing 2a continued:

```
F041 3246F0           LD (DATA4),A      ;SAVE ANSWER
F044 C9               RET               ;RETURN TO BASIC
                ;
F045 00         DATA3 DEFB 00H          ;DATA FROM BASIC
F046 00         DATA4 DEFB 00H          ;ANSWER FOR BASIC
                ;
0000                  END               ;END OF ROUTINES
```

(b)

```
10 REM ASSEMBLY PROGRAM ALREADY LOADED
20 REM BASIC MEMORY SIZE SET AT 0EFFFH
30 DEFUSR0 = &HF000: REM ENTRY POINT FOR ROUTINE 0
40 DEFUSR1 = &HF027: REM ENTRY POINT FOR ROUTINE 1
                    .
                    .
                    .
100 POKE &HF025,B: REM SEND DATA TO ROUTINE 0
110 A=USR0(X): REM EXECUTE ROUTINE 0
120 C=PEEK(&HF026): REM GET THE ANSWER
                    .
                    .
                    .
200 POKE &HF045,D: REM SEND DATA TO ROUTINE 1
210 A=USR1(X): REM EXECUTE ROUTINE 1
220 E=PEEK(&HF046): REM GET THE ANSWER
                    .
                    .
                    .
300 END
```

Listing 3: *An assembly-language routine (a), including jump and data tables, and a BASIC program (b), which calls the assembly-language routine via the jump and data tables.*

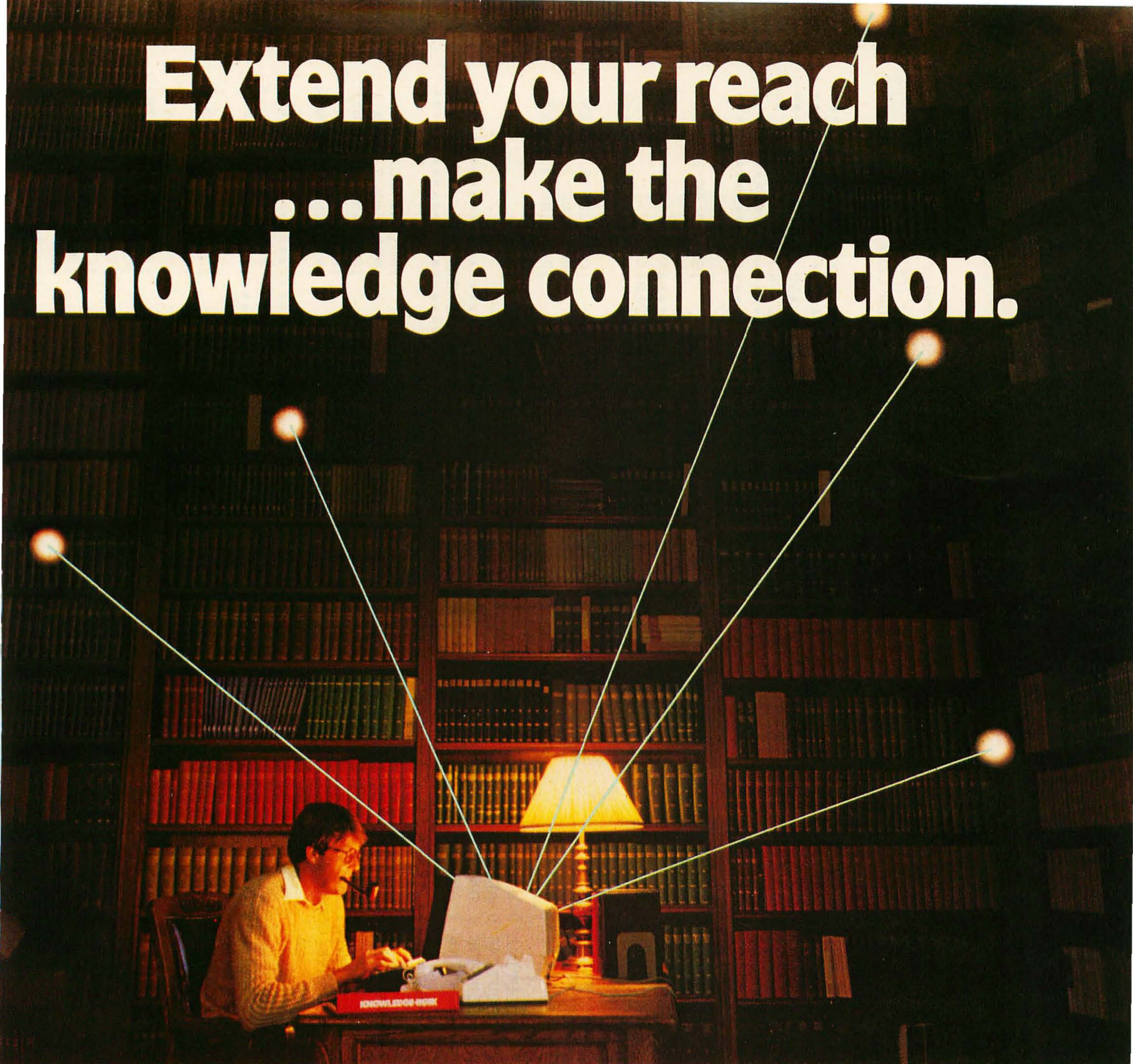
(a)

```
                ;************************************
                ;************************************
                ;**   ASSEMBLY LANGUAGE SUBROUTINE  **
                ;**      TO BE CALLED FROM BASIC    **
                ;************************************
                ;************************************
                ;
F000                   ORG 0F000H      ;START AT F000H
                ;
                ;************************************
                ;*            JUMP TABLE            *
                ;************************************
                ;
F000 C313F0     ENTRY0 JP RTN0         ;ROUTINE 0 ENTRY
F003 C336F0     ENTRY1 JP RTN1         ;ROUTINE 1 ENTRY
F006 C30000     ENTRY2 JP 0000H        ;SPARE
F009 C30000     ENTRY3 JP 0000H        ;SPARE
F00C C30000     ENTRY4 JP 0000H        ;SPARE
                ;
                ;************************************
                ;*            DATA TABLE            *
                ;************************************
                ;
F00F 00         DATA1  DEFB 00H        ;ROUTINE 0 DATA
F010 00         DATA2  DEFB 00H        ;ROUTINE 0 ANSWER
F011 00         DATA3  DEFB 00H        ;ROUTINE 1 DATA
F012 00         DATA4  DEFB 00H        ;ROUTINE 1 ANSWER
                ;
                ;************************************
                ;*             ROUTINE 0            *
                ;************************************
                ;
F013 3A0FF0     RTN0   LD A,(DATA1)    ;1ST ENTRY POINT
F016 0605              LD B,05H        ;IGNORE CODE
                          .
                          .
                          .
F032 3210F0            LD (DATA2),A    ;SAVE ANSWER
F035 C9                RET             ;RETURN TO BASIC
                ;
                ;************************************
                ;*             ROUTINE 1            *
                ;************************************
                ;
F036 3A11F0     RTN1   LD A,(DATA3)    ;2ND ENTRY POINT
F039 CB27              SLA A           ;IGNORE CODE
                          .
                          .
                          .
F050 3212F0            LD (DATA4),A    ;SAVE ANSWER
F053 C9                RET             ;RETURN TO BASIC
                ;
0000                   END             ;END OF ROUTINES
```

(b)

```
10 REM ASSEMBLY PROGRAM ALREADY LOADED
20 REM BASIC MEMORY SIZE SET AT 0EFFFH
30 DEFUSR0 = &HF000: REM JUMP TABLE ENTRY FOR ROUTINE 0
40 DEFUSR1 = &HF003: REM JUMP TABLE ENTRY FOR ROUTINE 1
                    .
                    .
                    .
100 POKE &HF00F,B: REM SEND ROUTINE 0 DATA TO DATA TABLE
110 A=USR0(X): REM EXECUTE ROUTINE 0
120 C=PEEK(&HF010): REM GET THE ANSWER FROM DATA TABLE
                    .
                    .
                    .
200 POKE &HF011,D: REM SEND ROUTINE 1 DATA TO DATA TABLE
210 A=USR1(X): REM EXECUTE ROUTINE 1
220 E=PEEK(&HF012): REM GET THE ANSWER FROM DATA TABLE
                    .
                    .
                    .
300 END
```

Listings continued on page 506


Extend your reach
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Listing 4: *The listing 3a code after the addition of one line of code (line 430). Note that although all addresses after line 430 have changed, the interface to BASIC through the jump and data tables remains unchanged.*

```
                00010 ;*************************************
                00020 ;*************************************
                00030 ;**   ASSEMBLY LANGUAGE SUBROUTINE   **
                00040 ;**      TO BE CALLED FROM BASIC     **
                00050 ;*************************************
                00060 ;*************************************
                00070 ;
F000            00080        ORG 0F000H      ;START AT F000H
                00090 ;
                00100 ;*************************************
                00110 ;*          JUMP TABLE               *
                00120 ;*************************************
                00130 ;
F000 C313F0     00140 ENTRY0 JP RTN0         ;ROUTINE 0 ENTRY
F003 C338F0     00150 ENTRY1 JP RTN1         ;ROUTINE 1 ENTRY
F006 C30000     00160 ENTRY2 JP 0000H        ;SPARE
F009 C30000     00170 ENTRY3 JP 0000H        ;SPARE
F00C C30000     00180 ENTRY4 JP 0000H        ;SPARE
                00190 ;
                00200 ;*************************************
                00210 ;*          DATA TABLE               *
                00220 ;*************************************
                00230 ;
F00F 00         00240 DATA1  DEFB 00H        ;ROUTINE 0 DATA
F010 00         00250 DATA2  DEFB 00H        ;ROUTINE 0 ANSWER
F011 00         00260 DATA3  DEFB 00H        ;ROUTINE 1 DATA
F012 00         00270 DATA4  DEFB 00H        ;ROUTINE 1 ANSWER
                00280 ;
                00290 ;*************************************
                00300 ;*          ROUTINE 0                *
                00310 ;*************************************
                00320 ;
F013 3A0FF0     00330 RTN0   LD A,(DATA1)    ;1ST ENTRY POINT
F016 0605       00340        LD B,05H        ;IGNORE CODE
                               .
                               .
                               .
F032 E67F       00430        AND 7FH         ;* ADD NEW CODE *
F034 3210F0     00440        LD (DATA2),A    ;SAVE ANSWER
F037 C9         00450        RET             ;RETURN TO BASIC
                00460 ;
                00470 ;*************************************
                00480 ;*          ROUTINE 1                *
                00490 ;*************************************
                00500 ;
F038 3A11F0     00510 RTN1   LD A,(DATA3)    ;2ND ENTRY POINT
F03B CB27       00520        SLA A           ;IGNORE CODE
                               .
                               .
                               .
F052 3212F0     00640        LD (DATA4),A    ;SAVE ANSWER
F055 C9         00650        RET             ;RETURN TO BASIC
                00660 ;
0000            00670        END             ;END OF ROUTINES
```

Listing 5: *An assembly-language listing (a) and a BASIC program (b) that illustrate expansion of the number of USER calls available from BASIC to 255. The assembly-language listing shows the jump-table technique used in conjunction with the CLCINX routine (lines 340 to 450) to calculate the desired entry point.*

(a)

```
                00010 ;*************************************
                00020 ;*************************************
                00030 ;**   ASSEMBLY LANGUAGE SUBROUTINE   **
                00040 ;**      TO BE CALLED FROM BASIC     **
                00050 ;*************************************
                00060 ;*************************************
                00070 ;
F000            00080        ORG 0F000H      ;START AT F000H
                00090 ;
                00100 ;*************************************
                00110 ;*          JUMP TABLE               *
                00120 ;*************************************
                00130 ;
F000 C314F0     00140 ENTRY0 JP CLCINX       ;CALCULATE INDEX
F003 C326F0     00150 ENTRY1 JP RTN1         ;ROUTINE 1 ENTRY
F006 C348F0     00160 ENTRY2 JP RTN2         ;ROUTINE 2 ENTRY
F009 C30000     00170 ENTRY3 JP 0000H        ;SPARE
F00C C30000     00180 ENTRY4 JP 0000H        ;SPARE
                00190 ;
                00200 ;*************************************
                00210 ;*          DATA TABLE               *
                00220 ;*************************************
                00230 ;
F00F 00         00240 INDEX  DEFB 00H        ;NO. OF ROUTINE
F010 00         00250 DATA1  DEFB 00H        ;ROUTINE 1 DATA
F011 00         00260 DATA2  DEFB 00H        ;ROUTINE 1 ANSWER
F012 00         00270 DATA3  DEFB 00H        ;ROUTINE 2 DATA
F013 00         00280 DATA4  DEFB 00H        ;ROUTINE 2 ANSWER
                00290 ;
                00300 ;*************************************
                00310 ;*   CALCULATE ENTRY FROM INDEX      *
                00320 ;*************************************
                00330 ;
F014 3A0FF0     00340 CLCINX LD A,(INDEX)    ;GET ROUTINE NO.
F017 B7         00350        OR A            ;IS IT ZERO?
F018 C8         00360        RET Z           ;IF YES, RETURN
F019 2600       00370        LD H,00H        ;ZERO H REGISTER
F01B 6F         00380        LD L,A          ;COPY INDEX TO L
F01C 1600       00390        LD D,00H        ;ZERO D REGISTER
F01E 5F         00400        LD E,A          ;COPY INDEX TO E
F01F 19         00410        ADD HL,DE       ;DOUBLE INDEX
F020 19         00420        ADD HL,DE       ;HL = 3 X (INDEX)
F021 1100F0     00430        LD DE,ENTRY0    ;JUMP TABLE START
```

Listing 5a continued on page 508

Listing 5a continued:

```
F024 19              ADD HL,DE        ;HL = ENTRY POINT
F025 E9              JP (HL)          ;GO TO JUMP TABLE
               ;
               ;************************************
               ;*            ROUTINE 1             *
               ;************************************
               ;
F026 3A10F0    RTN1  LD A,(DATA1)     ;2ND ENTRY POINT
F029 0605            LD B,05H         ;IGNORE CODE
                     .
                     .
                     .
F044 3211F0          LD (DATA2),A     ;SAVE ANSWER
F047 C9              RET              ;RETURN TO BASIC
               ;
               ;************************************
               ;*             ROUTINE 2            *
               ;************************************
               ;
F048 3A12F0    RTN2  LD A,(DATA3)     ;3RD ENTRY POINT
F04B CB27            SLA A            ;IGNORE CODE
                     .
                     .
                     .
F067 3213F0          LD (DATA4),A     ;SAVE ANSWER
F06A C9              RET              ;RETURN TO BASIC
               ;
0000                 END              ;END OF ROUTINES
```

(b)

```
10 REM ASSEMBLY PROGRAM ALREADY LOADED
20 REM BASIC MEMORY SIZE SET AT 0EFFFH
30 DEFUSR = &HF000: REM ENTRY POINT FOR INDEX ROUTINE
40 REM POKE NUMBER OF DESIRED ROUTINE AT 0F00FH
50 REM AND CALL USER0 TO EXECUTE
                   .
                   .
                   .
100 POKE &HF010,B: REM SEND DATA TO ROUTINE 1
110 POKE &HF00F,1: A=USR(X): REM EXECUTE ROUTINE 1
120 C=PEEK(&HF011): REM GET THE ANSWER
                   .
                   .
                   .
200 POKE &HF012,D: REM SEND DATA TO ROUTINE 2
210 POKE &HF00F,2: A=USR(X): REM EXECUTE ROUTINE 2
220 E=PEEK(&HF013): REM GET THE ANSWER
                   .
                   .
                   .
300 END
```

Listing 6: *A jump table of the BIOS for Digital Research's CP/M 2.2 operating system. The routines accessed from the jump table are customized for a specific hardware environment.*

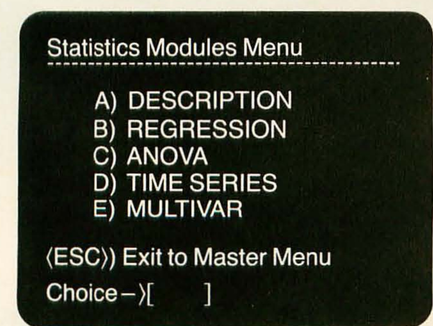
```
               ;************************************
               ;************************************
               ;**    EXAMPLE OF BIOS JUMP TABLE   **
               ;**   FOR DIGITAL RESEARCH CP/M 2.2 **
               ;************************************
               ;************************************
               ;
4A00                 ORG   4A00H      ;BASE OF BIOS FOR
                                      ;  20K SYSTEM
               ;
4A00 C3B74A          JP BOOT          ;COLD START ENTRY
4A03 C3CF4A          JP WBOOT         ;WARM START
4A06 C3E14A          JP CONST         ;CONSOLE IN STATUS
4A09 C3EA4A          JP CONIN         ;CONSOLE INPUT
4A0C C3F64A          JP CONOUT        ;CONSOLE OUTPUT
4A0F C3124B          JP LIST          ;LIST DEVICE OUT
4A12 C32C4B          JP PUNCH         ;PUNCH OUTPUT
4A15 C33B4B          JP READER        ;READER INPUT
4A18 C34C4B          JP HOME          ;DISK TO TRACK 0
4A1B C35A4B          JP SELDSK        ;SELECT DISK
4A1E C3714B          JP SETTRK        ;SET TRACK NO.
4A21 C3874B          JP SETSEC        ;SET SECTOR NO.
4A24 C39F4B          JP SETDMA        ;SET BUFFER ADDR
4A27 C3AE4B          JP READ          ;READ SECTOR
4A2A C3BF4B          JP WRITE         ;WRITE SECTOR
4A2D C3D24B          JP LISTST        ;GET LIST STATUS
4A30 C3EC4B          JP SECTRAN       ;TRANSLATE SECTOR
               ;
               ;************************************
               ;*     BIOS ROUTINES GO HERE        *
               ;************************************
               ;
                     .
                     .
                     .
0000                 END              ;END OF BIOS
```

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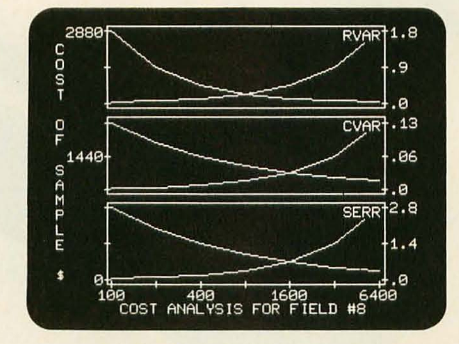
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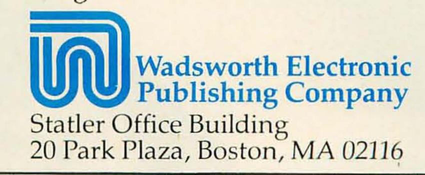
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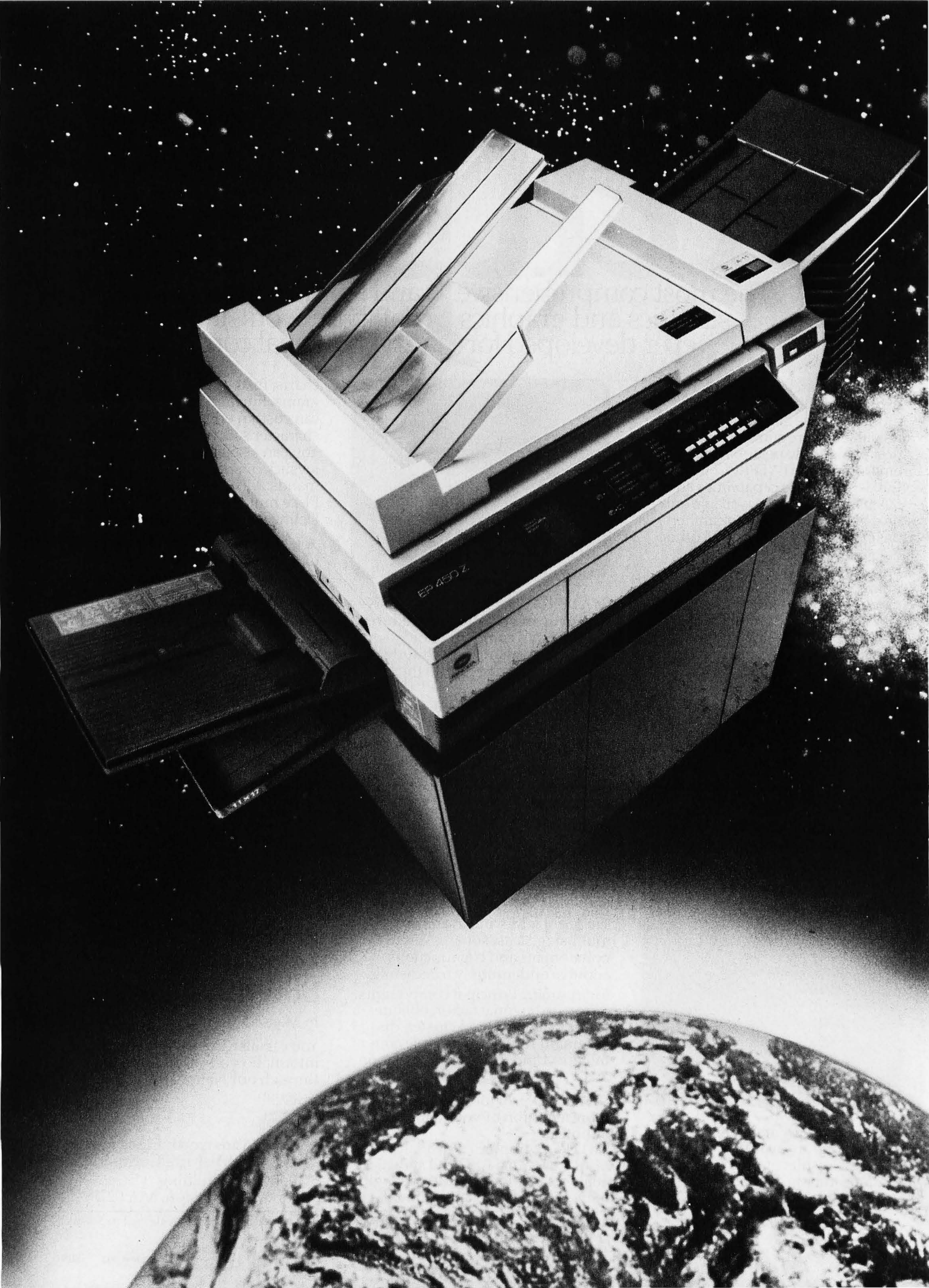
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BY-9

Listing 1a: *The BASIC-language portion of the routines to test and demonstrate the Micro D-Cam.*

```
10  REM MICRO DCAM DEMONSTRATION
15  REM PROGRAM
20  REM
25  REM  COPYRIGHT (C) 1983 BY
30  REM   CIRCUIT CELLAR, INC.
35  REM
40  HGR : TEXT : HOME
50  PRINT  CHR$ (4)"BLOAD MICRO D
     CAM"
60  INPUT "ENTER CAMERA SLOT: ";S
     L
70  IF SL < 1 OR SL > 7 THEN 60
80  POKE 770,SL * 16: REM SLOT NU
     MBER
90  POKE 768,0: POKE 769,1: REM E
     XPOSURE TIME
100  POKE 771,0: REM UPPER 1/3 OF
      SCREEN
110  CALL 4096: REM UPDATE SCRN
120  IF  PEEK (773) = 0 THEN 130:
      REM CHECK FOR KEYPRESS
130  IF  PEEK (772) = 209 THEN  TEXT
     : HOME : END : REM CHECK FOR
      'Q'
140  GOTO 110
```

Listing 1b: *Micro D-Cam control subroutines, written in 6502 assembly language, called as a machine-language module by the BASIC routine of listing 1.*

```
:ASM

                1   ****************************************
                2   * MICRO DCAM SUPPORT ROUTINES
                3   *
                4   *   COPYRIGHT (C) 1983
                5   *     BY CIRCUIT CELLAR, INC.
                6   *
                7   * WHEN CALLED, THIS ROUTINE READS
                8   *  AN IMAGE FROM THE CAMERA AND
                9   *  DISPLAYS IT ON THE APPLE'S HI-RES
                10  *  GRAPHICS SCREEN
                11  ****************************************
                12           ORG  $1000
                13  KEYCLR   EQU  $C010
                14  KEYHIT   EQU  $C000
                15  BEEP     EQU  $C030
                16  GMODE    EQU  $C050
                17  TMODE    EQU  $C051
                18  MIXED    EQU  $C053
                19  PAGE1    EQU  $C054
                20  HGR      EQU  $C057
                21  STATUS   EQU  $C08E
                22  DATA     EQU  $C08F
                23  *
                24  SOAKTIME EQU  $300
                25  SLOTADR  EQU  $302
                26  ROWSTART EQU  $303
                27  KEY      EQU  $304
                28  KEYEXIT  EQU  $305
                29  *
                30  RADR     EQU  $06
                31  CTR      EQU  $08
                32  YREG     EQU  $19
                33  *
1000: 20 B9 10  34           JSR  SETGR      ;SET UP FOR HIRES PAGE1
1003: 20 8F 10  35  NSTART   JSR  ACIACLR    ;FLUSH THE INPUT BUFFER
1006: A9 D3     36           LDA  #$D3       ;SEND CMD TO SOAK W/O SEND
1008: 20 C6 10  37           JSR  SENDCMD
100B: 20 DA 10  38           JSR  SOAK
100E: A9 C0     39           LDA  #$C0       ;SEND IMAGE W/O SOAK
1010: 20 C6 10  40           JSR  SENDCMD    ;(ALT,WIDEPIX,7BIT-256X64)
1013: A2 00     41           LDX  #0         ;INITIALIZE THE ROW INDEX
1015: A0 00     42  NEWROW   LDY  #0         ;INIT COLUMN INDEX (Y)
1017: BD 08 11  43           LDA  ROWPTR,X   ;BUILD BASE ADDRS FOR CUR ROW
101A: 18        44           CLC
101B: 6D 03 03  45           ADC  ROWSTART   ;0-SELECT UPPER 1/3 OF SCREEN
101E: 85 06     46           STA  RADR       ;$28-MID 1/3,$50-BOT 1/3
1020: E8        47           INX             ;RADR HAS ADDRS OF CUR ROW
1021: BD 08 11  48           LDA  ROWPTR,X
1024: 85 07     49           STA  RADR+1
1026: E8        50           INX             ;PNT X TO NXT ADDRS IN ROWPTR
1027: 84 19     51  GET      STY  YREG       ;GET NEXT BYTE FROM CAMERA
1029: AC 02 03  52           LDY  SLOTADR    ;LOAD OFFSET TO CAMERA SLOT
102C: B9 8E C0  53           LDA  STATUS,Y   ;CHECK IF NEXT BYTE ARRIVED
```

Listing continued on page 514

Everybody's making money selling microcomputers. Somebody's going to make money servicing them.



Now NRI Trains You At Home To Make Money Servicing, Repairing, and Programming Personal and Small Business Computers

Seems like every time you turn around, somebody comes along with a new computer for home or business use. And what's made it all possible is the amazing microprocessor, the tiny little chip that's a computer in itself.

Using this new technology, the industry is offering compact, affordable computers that handle things like payrolls, billing, inventory, and other jobs for business of every size...perform household functions including budgeting, environmental systems control, indexing recipes. And thousands of hobbyists are already owners, experimenting and developing their own programs.

Growing Demand for Computer Technicians

This is only one of the growth factors influencing the increasing opportunities for qualified computer technicians. The U.S. Department of Labor projects over a 600% increase in job openings for the decade. Most of them are *new* jobs created by the expanding world of the computer.

Learn At Home to Service Any Computer

NRI can train you for this exciting, rewarding field. Train you at home to service not only microcomputers, but word processors and data terminals, too. Train you at your convenience, with clearly written "bite-size" lessons that you do evenings or weekends, without going to classes or quitting your present job.

Your training is built around the latest model of the world's most popular computer. It's the amazing TRS-80™ Model 4, now with disk drive and the capabilities and features to perform a host of personal and business functions. No other small computer has so much software available for it, no other is used and relied on by so many people. And it's yours to keep for personal and business use.

You get plenty of practical experience. Under NRI's carefully planned training, you even install a *disk drive* verifying at each step its operation. Using the NRI Discovery Lab® that also comes as part of your course, you build and study circuits ranging from the simplest to the most advanced. You analyze and troubleshoot using the professional 4-function LCD digital multimeter you keep to use later in your work. Then you use the lab and meter to actually access the interior of your computer...build special circuits and write programs to control them. You "see" your computer at work and demonstrate its power.

Same Training Available With Color Computer

NRI offers you the opportunity to train with the TRS-80 Color Computer as an alternative to the Model 4. The same technique for getting inside is enhanced by using the new NRI-developed Computer Access Card. Only NRI offers you a choice to fit your specific training needs.

(TRS-80 is a trademark of the Radio Shack division of Tandy Corp.)



Become the Complete Computer Person

In addition to training in BASIC and advanced machine language, you gain hands-on experience in the operation and application of the latest computers for both business and personal jobs. You're trained to become the fully rounded, new breed of technician who can interface with the operational, programming, and service facets of all of today's computers. You're ready to take your place in the new electronic age.

Other Opportunities

NRI has been giving ambitious people new electronic skills since 1914. Today's offerings also include TV/Audio/Video Systems servicing with training on our exclusive Heath/Zenith computer-programmable 25" diagonal color TV...Industrial Electronics, Design Technology...and other state-of-the-art courses.

The Catalog Is Free. The Training is Priceless.

Send the postage-paid card for our 104-page catalog showing all courses with equipment and complete lesson plans. There's no obligation other than to yourself. See how NRI can help you take advantage of the exciting job and earnings opportunities in the exploding field of microcomputers. If card has been removed, please write to us.



NRI Schools
McGraw-Hill Continuing Education Center
3939 Wisconsin Ave.
Washington, DC 20016

We'll give you tomorrow.

Listing 1b continued:

```
102F: 4A                    LSR
1030: B0 21                 BCS  NORM3     ;IF BYTE AVAILABLE BRANCH
1032: A9 00                 LDA  #0        ;IF BYTE NOT YET AVAILABLE
1034: 85 08                 STA  CTR       ;SET UP TIMEOUT COUNTER
1036: A9 15                 LDA  #$15
1038: 85 09                 STA  CTR+1
103A: C6 08        NORM1    DEC  CTR       ;CHK FOR BYTE UNTIL TIMED OUT
103C: D0 0F                 BNE  NORM2
103E: C6 09                 DEC  CTR+1
1040: D0 0B                 BNE  NORM2
1042: AD 30 C0              LDA  BEEP      ;IF TIMED OUT, CLICK SPEAKER
1045: AD 00 C0              LDA  KEYHIT    ;CHECK FOR KEYPRESS
1048: 30 1D                 BMI  NDONE     ;IF KEY HIT THEN RETURN
104A: 4C 03 10              JMP  NSTART    ;OTHERWISE, TRY COMMAND AGAIN
104D: B9 8E C0     NORM2    LDA  STATUS,Y
1050: 4A                    LSR
1051: 90 E7                 BCC  NORM1
1053: B9 8F C0     NORM3    LDA  DATA,Y    ;WHEN BYTE AVAILABLE GET IT
1056: A4 19                 LDY  YREG      ;RESTORE COL POINTER TO Y
1058: C0 28                 CPY  #40       ;IF PAST 40TH BYTE IN CUR ROW,
105A: B0 02                 BGE  NORM4     ;DONT PUT ONTO HIRES SCREEN
105C: 91 06                 STA  (RADR),Y
105E: C8           NORM4    INY            ;INCREMENT COLUMN POINTER
105F: C0 25                 CPY  #37       ;END OF THE COLUMN?
1061: D0 C4                 BNE  GET       ;IF NOT, GET THE NEXT BYTE
1063: E0 80                 CPX  #$80      ;OTHERWISE
1065: D0 AE                 BNE  NEWROW    ;IF NOT DONE, GOTO NEXTROW
1067: A9 D1        NDONE    LDA  #$D1
1069: 20 C6 10              JSR  SENDCMD
106C: A9 20                 LDA  #$20      ;CLR 'EXIT CAUSED BY KEY' FLAG
106E: 8D 04 03              STA  KEY       ;AND BLANK THE KEY VALUE
1071: A9 00                 LDA  #0
1073: 8D 05 03              STA  KEYEXIT
1076: AD 00 C0              LDA  KEYHIT    ;CHECK IF KEY WAS HIT
1079: 10 13                 BPL  KEY1
107B: 2C 10 C0              BIT  KEYCLR    ;CLEAR THE KEYBOARD STROBE
107E: EE 05 03              INC  KEYEXIT   ;SET 'EXIT CAUSED BY KEY' FLAG
1081: 8D 04 03              STA  KEY
1084: C9 D1                 CMP  #"Q"      ;IF THE KEY WAS A 'Q'
1086: D0 06                 BNE  KEY1
1088: 20 A1 10              JSR  GRCLR     ;CLEAR THE GRAPHICS SCREEN
108B: AD 51 C0              LDA  TMODE     ;RETURN TO TEXT MODE
108E: 60           KEY1     RTS
                   *
108F: A9 03        ACIACLR  LDA  #3        ;MASTER RESET ACIA
1091: 84 19                 STY  YREG
1093: AC 02 03              LDY  SLOTADR
1096: 99 8E C0              STA  STATUS,Y
1099: A9 14                 LDA  #$14      ;1 START,8 DATA,1 STOP,EXT CLK
109B: 99 8E C0              STA  STATUS,Y
109E: A4 19                 LDY  YREG
10A0: 60                    RTS
                   *
10A1: A2 00        GRCLR    LDX  #0        ;CLEAR PAGE1 OF HIRES
10A3: A0 00                 LDY  #0
10A5: 84 06                 STY  RADR
10A7: A9 20                 LDA  #$20
10A9: 85 07                 STA  RADR+1
10AB: 8A                    TXA
10AC: 91 06        CLR1     STA  (RADR),Y
10AE: C8                    INY
10AF: D0 FB                 BNE  CLR1
10B1: E6 07                 INC  RADR+1
10B3: E8                    INX
10B4: E0 20                 CPX  #$20
10B6: D0 F4                 BNE  CLR1
10B8: 60                    RTS
                   *
10B9: AD 53 C0     SETGR    LDA  MIXED     ;SET MIXED MODE
10BC: AD 57 C0              LDA  HGR       ;USE HIRES GRAPHICS
10BF: AD 54 C0              LDA  PAGE1     ;USE PAGE1 OF HIRES
10C2: AD 50 C0              LDA  GMODE     ;SWITCH TO GRAPHICS MODE
10C5: 60                    RTS
                   *
10C6: 84 19        SENDCMD  STY  YREG      ;SEND BYTE IN A TO CAMERA
10C8: AC 02 03              LDY  SLOTADR
10CB: 48                    PHA
10CC: B9 8E C0     SEND1    LDA  STATUS,Y
10CF: 29 02                 AND  #2
10D1: F0 F9                 BEQ  SEND1
10D3: 68                    PLA
10D4: 99 8F C0              STA  DATA,Y
10D7: A4 19                 LDY  YREG
10D9: 60                    RTS
```

Listing continued on page 516

Listing 1b continued:

```
                 138 *
10DA: AD 01 03 139 SOAK     LDA  SOAKTIME+1 ;SOAK FOR NUMBER OF MS
10DD: 85 09    140          STA  CTR+1      ;SPECIFIED BY SOAKTIME
10DF: E6 09    141          INC  CTR+1
10E1: AD 00 03 142          LDA  SOAKTIME
10E4: 85 08    143          STA  CTR
10E6: E6 08    144          INC  CTR
10E8: AD 00 03 145          LDA  SOAKTIME
10EB: D0 05    146          BNE  SOAK1
10ED: AD 01 03 147          LDA  SOAKTIME+1
10F0: F0 0B    148          BEQ  SOAK2
10F2: 20 FE 10 149 SOAK1    JSR  MSEC
10F5: C6 08    150          DEC  CTR
10F7: D0 F9    151          BNE  SOAK1
10F9: C6 09    152          DEC  CTR+1
10FB: D0 F5    153          BNE  SOAK1
10FD: 60       154 SOAK2    RTS
               155 *
10FE: 84 19    156 MSEC     STY  YREG       ;1 MILLISECOND LOOP
1100: A0 C7    157          LDY  #199
1102: 88       158 MSEC1    DEY
1103: D0 FD    159          BNE  MSEC1
1105: A4 19    160          LDY  YREG
1107: 60       161          RTS
               162 *
1108: 00 20 00
110B: 24 00 28
110E: 00 2C 00
1111: 30 00 34
1114: 00 38 00
1117: 3C       163 ROWPTR   HEX  00200024002800 2C003000340038003C
1118: 80 20 80
111B: 24 80 28
111E: 80 2C 80
1121: 30 80 34
1124: 80 38 80
1127: 3C       164          HEX  802080248028802C803080348038803C
1128: 00 21 00
112B: 25 00 29
112E: 00 2D 00
1131: 31 00 35
1134: 00 39 00
1137: 3D       165          HEX  002100250029002D003100350039003D
1138: 80 21 80
113B: 25 80 29
113E: 80 2D 80
1141: 31 80 35
1144: 80 39 80
1147: 3D       166          HEX  802180258029802D803180358039803D
1148: 00 22 00
114B: 26 00 2A
114E: 00 2E 00
1151: 32 00 36
1154: 00 3A 00
1157: 3E       167          HEX  00220026002A002E003200360 03A003E
1158: 80 22 80
115B: 26 80 2A
115E: 80 2E 80
1161: 32 80 36
1164: 80 3A 80
1167: 3E       168          HEX  80228026802A802E803280368 03A803E
1168: 00 23 00
116B: 27 00 2B
116E: 00 2F 00
1171: 33 00 37
1174: 00 3B 00
1177: 3F       169          HEX  00230027002B002F003300370 03B003F
1178: 80 23 80
117B: 27 80 2B
117E: 80 2F 80
1181: 33 80 37
1184: 80 3B 80
1187: 3F       170          HEX  80238027802B802F803380378 03B803F
1188: 28 20 28
118B: 24 28 28
118E: 28 2C 28
1191: 30 28 34
1194: 28 38 28
1197: 3C       171          HEX  282028242828282C283028342838283C
1198: A8 20 A8
119B: 24 A8 28
119E: A8 2C A8
11A1: 30 A8 34
11A4: A8 38 A8
```

Listing continued on page 518

Introducing a sensible solution to the problems of dBASE II.™

	dBASE II	The Sensible Solution
Records Per File	65,535	999,999
Maximum Record Size	1,024 bytes	1,536 bytes
Fields Per Record	32	384
Key Fields Per File	7	10
Number of Files Simultaneously Accessible	2	10
Number of Screens Per Program	Limited by system memory	Limited only by system storage
Data Dictionary	No	Yes

We don't mean to debase dBASE II, but if you're looking for a data base manager that's long on features, dBASE II can come up a little short.

For instance, a single dBASE II record can only contain 32 fields. And when you need to share information between one file and another, you can only access two at a time.

So, as good as dBASE II is, its limitations can quickly paint you into an electronic corner.

And that's why we created *The Sensible Solution.*

Finally. A sensational relational.

Along with all the usual things you expect from a data base manager, *The Sensible Solution* lets you handle the kind of tough assignments that dBASE II can't:

You can design data files with more than 300 variables. You can create reports using 10 different files at once. You can even set up file locking for multi-user computers.

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A data base manager without ready-to-run application programs is hardly worth the disk it's copied on.

So, along with *The Sensible Solution,* you can also add *The Sensible Solution Bookkeeper*™ or *Sensible Management,*™ our complete one-entry accounting and management system.

They're both affordable. Business-tested. And supplied with source code so you can make your own modifications.

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When you purchase *The Sensible Solution,* we'll send along a special trial disk that lets you create forms and enter a limited number of records. If, after 30 days, you're not satisfied, just return the unopened master system disk for a full refund.

So why not take us up on our trial offer? You've got nothing to lose.

Except the problems of dBASE II.

The Sensible Solution™

To order, write or call: O'Hanlon Computer Systems, 11058 Main Street, Bellevue, WA 98004 USA, Phone (206) 454-2261. Prices: *The Sensible Solution*—$695, *Sensible Solution Bookkeeper*—$495, *Sensible Management*—$895. In Washington, add 6.5% state tax. VISA, Mastercard and dealer inquiries welcome.

Circle 332 on inquiry card.

Listing 1b continued:

```
11A7: 3C        172          HEX  A820A824A828A82CA830A834A838A83C
11A8: 28 21 28
11AB: 25 28 29
11AE: 28 2D 28
11B1: 31 28 35
11B4: 28 39 28
11B7: 3D        173          HEX  28212825282928 2D283128352839283D
11B8: A8 21 A8
11BB: 25 A8 29
11BE: A8 2D A8
11C1: 31 A8 35
11C4: A8 39 A8
11C7: 3D        174          HEX  A821A825A829A82DA831A835A839A83D
11C8: 28 22 28
11CB: 26 28 2A
11CE: 28 2E 28
11D1: 32 28 36
11D4: 28 3A 28
11D7: 3E        175          HEX  28222826282A282E28322836283A283E
11D8: A8 22 A8
11DB: 26 A8 2A
11DE: A8 2E A8
11E1: 32 A8 36
11E4: A8 3A A8
11E7: 3E        176          HEX  A822A826A82AA82EA832A836A83AA83E
11E8: 28 23 28
11EB: 27 28 2B
11EE: 28 2F 28
11F1: 33 28 37
11F4: 28 3B 28
11F7: 3F        177          HEX  28232827282B282F28332837283B283F
11F8: A8 23 A8
11FB: 27 A8 2B
11FE: A8 2F A8
1201: 33 A8 37
1204: A8 3B A8
1207: 3F        178          HEX  A823A827A82BA82FA833A837A83BA83F


--END ASSEMBLY--

ERRORS: 0
```

```
520 BYTES


SYMBOL TABLE - ALPHABETICAL ORDER:

   ACIACLR =$108F     BEEP    =$C030     CLR1    =$10AC     CTR     =$08
   DATA    =$C08F     GET     =$1027     GMODE   =$C050     GRCLR   =$10A1
   HGR     =$C057     KEY     =$0304     KEY1    =$108E     KEYCLR  =$C010
   KEYEXIT =$0305     KEYHIT  =$C000     MIXED   =$C053     MSEC    =$10FE
   MSEC1   =$1102     NDONE   =$1067     NEWROW  =$1015     NORM1   =$103A
   NORM2   =$104D     NORM3   =$1053     NORM4   =$105E     NSTART  =$1003
   PAGE1   =$C054     RADR    =$06       ROWPTR  =$1108     ROWSTART=$0303
   SEND1   =$10CC     SENDCMD =$10C6     SETGR   =$10B9     SLOTADR =$0302
   SOAK    =$10DA     SOAK1   =$10F2     SOAK2   =$10FD     SOAKTIME=$0300
   STATUS  =$C08E     TMODE   =$C051     YREG    =$19


SYMBOL TABLE - NUMERICAL ORDER:

   RADR    =$06       CTR     =$08       YREG    =$19       SOAKTIME=$0300
   SLOTADR =$0302     ROWSTART=$0303     KEY     =$0304     KEYEXIT =$0305
   NSTART  =$1003     NEWROW  =$1015     GET     =$1027     NORM1   =$103A
   NORM2   =$104D     NORM3   =$1053     NORM4   =$105E     NDONE   =$1067
   KEY1    =$108E     ACIACLR =$108F     GRCLR   =$10A1     CLR1    =$10AC
   SETGR   =$10B9     SENDCMD =$10C6     SEND1   =$10CC     SOAK    =$10DA
   SOAK1   =$10F2     SOAK2   =$10FD     MSEC    =$10FE     MSEC1   =$1102
   ROWPTR  =$1108     KEYHIT  =$C000     KEYCLR  =$C010     BEEP    =$C030
   GMODE   =$C050     TMODE   =$C051     MIXED   =$C053     PAGE1   =$C054
   HGR     =$C057     STATUS  =$C08E     DATA    =$C08F
```

Listing 2a: *The BASIC portion of the GREY16 program that produces dithered gray-scale output on the Apple II's video screen from the Micro D-Cam's output.*

```
10  REM GREY16BAS
12  REM
13  REM  COPYRIGHT (C) 1983
15  REM  BY CIRCUIT CELLAR, INC.
17  REM
18  REM "LOAD ROUTINES AND INITIA
     LIZE VARIABLES
19  REM
```

Listing continued on page 520

Will This Happen to You?

NOT IF YOU BUY YOUR PRINTER FROM...



After reading this issue of ***BYTE Magazine,*** you are now fully aware of the many outstanding printers on the market today. But what you might not be aware of is that the printer you like best, might not be compatible with your computer and software. (The picture above is good example of printer incompatibility). At the **Printer Store,**we specialize in printers, so our experienced professional staff can help you choose the right printer for your personal and business needs. If you want the **Best Value, Low Price, Product Availability,** and **Support,** call The Printer Store and ask us about:

- **FREE TECHNICAL CONSULTATION**
- **FULL AFTER SALE SUPPORT**
- **FULL FACTORY AUTHORIZED SERVICE**

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- 120 CPS - 1.3K Buffer - 144x60 dots 1 inch Nx9 dot matrix - Proportional Spacing - 8 Character sizes - 5 unique alphabets - Greek character set - Graphic symbols - bi-directional, logic-seeking - Adjustable tractors - Single-sheet friction feed - Vertical & horizontal tabbing.

C. ITOH 8510 Prowriter ..... List $795 **$ 395**

BROTHER HR-1

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- IBM Selectric type ribbon - Prints up to 6 copies
- Ideal for word processing

Parallel .... List 1100 **$ Call**

Serial .... List 1200 **$ Call**

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83A	$ CALL
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93A	$ CALL
84 (parallel)	$ CALL
C. ITOH SERIES	
8510 Prowriter	$ 395
Prowriter II	$ CALL
New! Banana	$ 239
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Microprism 480	$ CALL
Prism 80	$ CALL
Prism 132	$ CALL
GEMINI SERIES	
Gemini 10X	$ CALL
Gemini 15	$ CALL
NEC 8023	$ 419
Toshiba P 1350	$ 1750

LETTER QUALITY PRINTERS

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HR-1 (parallel)	$ CALL
HR-1 (serial)	$ CALL
HR-15	$ CALL
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CR-1 (serial)	$ 865
CR-2	$ CALL
C.ITOH SERIES	
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F10 55 CPS	$ CALL
Daisywriter 48K	$ CALL
NEC SERIES	
3510	$ CALL
3530	$ CALL
3550	$ CALL
7710	$ 2425
7720	$ 2900
7730	$2400
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Circle 373 on inquiry card.

THE Printer STORE – 2720 S. Harbor Blvd., Suite E, Santa Ana, CA 92704

Listing 2a continued:

```
20  HGR : TEXT : HOME : PRINT  CHR$
      (4)"BLOAD GREY16-48K"
40 NRM = 4096:FULL = 4099:GY = 41
      02
50 CAM = NRM
60 SOAK = 256:LO = 128:HI = 384
70 INC = (HI - LO) / 15
80 SL = 768:SH = 769:ST = 770:SP =
      771:KEY = 772:KP = 773:EI =
      774
90  HOME : INPUT "ENTER  CAMERA S
      LOT: ";SN: IF SN < 1 OR SN >
      7 THEN 90
100  POKE ST,SN * 20: REM "SLOT N
      UMBER
110  POKE SP,0: REM "SCREEN POSIT
      ION
117  REM
118  REM "KEYBOARD PROCESSOR SEC
119  REM
120  POKE SH, INT (SOAK / 256): POKE
      SL,SOAK -  INT (SOAK / 256) *
      256: REM "SOAK TIME
130  HOME : VTAB 21: PRINT  TAB(
      11);"CURRENT EXP: "SOAK" MS
       ": PRINT : PRINT "LO EXP: "
      ;LO;" MS  "; TAB( 24);"HI EX
      P: ";HI;" MS  "
140  CALL CAM: REM "READ CAMERA A
      ND DISPLAY PICTURE IN CURREN
      T MODE
150  IF  NOT ( PEEK (KP)) THEN 14
      0: REM "CHECK FOR KEYPRESS
160 KEY$ =  CHR$ ( PEEK (KEY) - 1
      28)
170  IF KEY$ = "E" THEN 400: REM
      "CHANGED EXPOSURE
180  IF KEY$ = "Q" THEN  TEXT : HOME
      : END : REM "QUIT PROGRAM
190  IF KEY$ = "N" THEN CAM = NRM
      : HGR : REM "NORMAL SIZE
200  IF KEY$ = "F" THEN CAM = FUL
      L: HGR : REM "FULL SIZE
210  IF KEY$ = "G" THEN  GOSUB 30
      0: REM "CREATE GREYSCALE PIC

220  IF KEY$ = "S" THEN  GOSUB 60
      0: REM "SAVE PICTURE
230  GOTO 120
297  REM
298  REM "CREATE GREYSCALE PIC
299  REM
300  HOME : VTAB 22: PRINT "COUNT
      DOWN: ";
310  POKE SL,LO -  INT (LO / 256)
       * 256: POKE SH, INT (LO / 2
      56): POKE EI,INC: REM "POKE
      STARTING EXPOSURE AND EXPOSU
      RE INCREMENT
320  CALL GY: REM "CREATE PIC
330  HOME : VTAB 22: PRINT "HIT '
      S' TO SAVE,": PRINT " ANY OT
      HER KEY TO CONTINUE.": GET K
      EY$
340  RETURN
397  REM
398  REM "CHANGE EXPOSURE
399  REM
400  HOME : VTAB 22: PRINT "CHANG
      E CURRENT, LO, OR": INPUT "
      HI EXPOSURE? (C,L,H): ";CH$
410  IF CH$ = "" THEN 120
420  IF CH$ <  > "C" THEN 460
430  INPUT "ENTER NEW CURRENT: ";
      NE$: IF NE$ = "" THEN 540
440 NE =  VAL (NE$): IF NE < 1 OR
      NE > 8000 THEN 430
450 SOAK = NE: GOTO 540
460  IF CH$ <  > "L" THEN 500
470  INPUT "ENTER NEW LO: ";NE$: IF
      NE$ = "" THEN 540
480 NE =  VAL (NE$): IF NE < 1 OR
      NE > 8000 OR NE > HI THEN 47
      0
490 LO = NE: GOTO 540
500  IF CH$ <  > "H" THEN 400
510  INPUT "ENTER NEW HI: ";NE$: IF
      NE$ = "" THEN 540
520 NE =  VAL (NE$): IF NE < 1 OR
      NE > 8000 OR NE < LO THEN 51
      0
530 HI = NE
540 INC = (HI - LO) / 15
550  GOTO 120
597  REM
598  REM "SAVE PICTURE ON DISK
599  REM
600  HOME : VTAB 22: PRINT "ENTER
       A NAME FOR": INPUT "THE PIC
      TURE: ";NA$
610  IF  LEN (NA$) <  = 0 THEN  RETURN

620  PRINT  CHR$ (4)"BSAVE "NA$",
      A$2000,L$2000"
630  HOME : RETURN
```

Listing 2b: *Assembly-language listing of the machine-code portion of the GREY16 program, called from BASIC.*

```
*******************************
*
* GREY16-48K
*
* COPYRIGHT (C) 1983
*  BY CIRCUIT CELLAR, INC.
*
*******************************
*
          ORG  $1000
KEYHIT    EQU  $C000
KEYCLR    EQU  $C010
BEEP      EQU  $C030
GMODE     EQU  $C050
TMODE     EQU  $C051
```

Listing continued on page 522



One company has sold more printers to this planet than anybody.

Epson.

By now, that shouldn't come as any surprise. After all, we *invented* digital printers for the 1964 Tokyo Olympics.

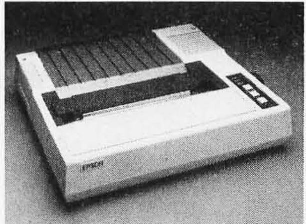
Since then, we've built more print mechanisms than the rest of the world combined. Including the world's smallest printers, the world's most reliable printers and the world's first disposable print head.

And today we are proud — but not surprised — to say that the world's best selling printers for small computers have the Epson name right on the front.

But the really amazing fact about Epson printers is this: they don't cost any more than other printers. In fact, they frequently cost less.

Here's how we got to be the world's best-selling printers: by building a quality product, by pricing it fairly and by standing behind it. That's the way we've done business for almost 20 years.

Only one printer can claim to be "number one." And measured by popular acceptance, by technological innovation, by honest-to-goodness value, not to mention sheer weight of numbers, that printer is Epson.



New Epson RX and FX dot matrix printers. At computer stores now.

Number One.
And built like it.

EPSON

EPSON AMERICA, INC.

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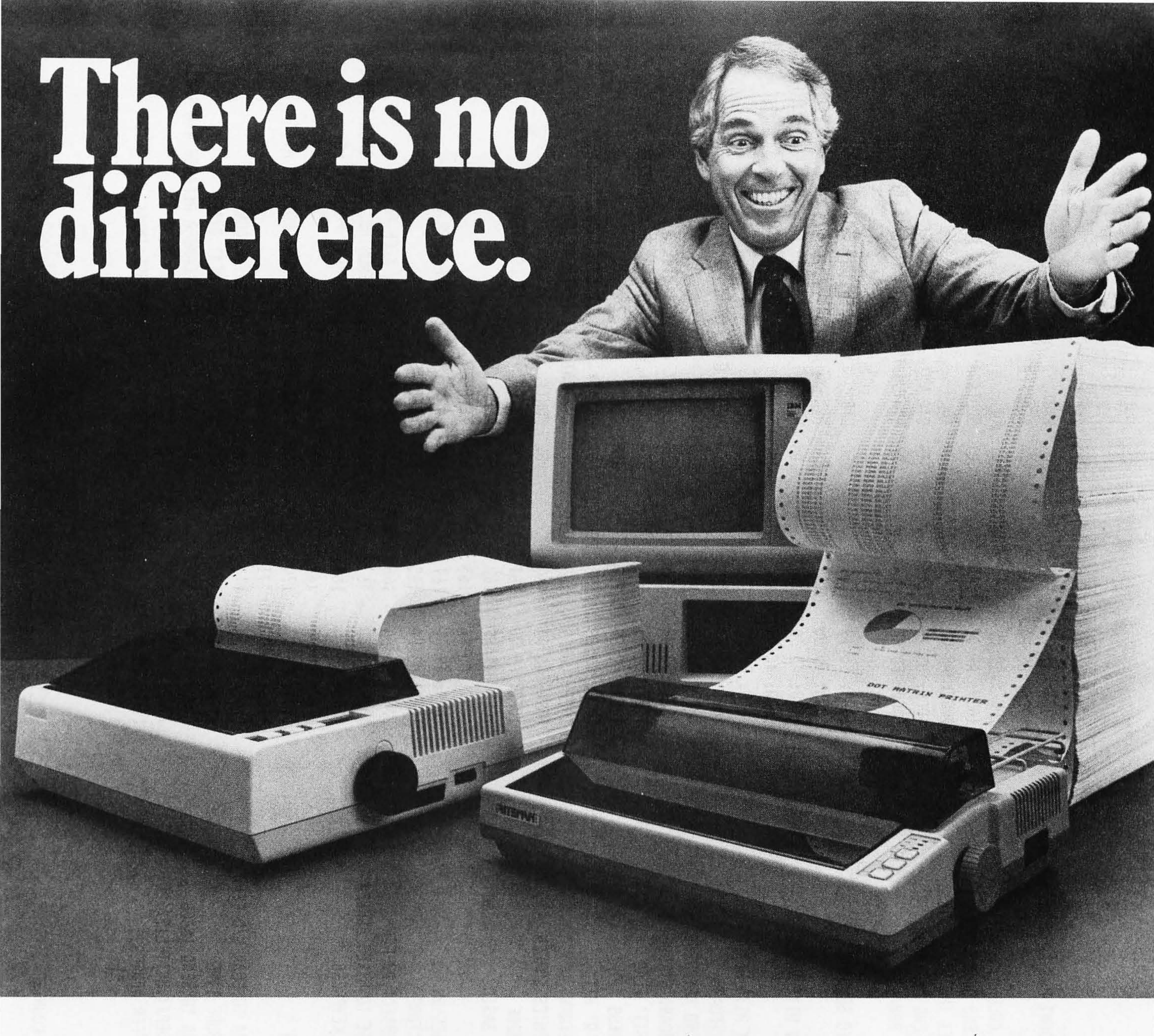
Please call (800) 421-5426 for the dealer nearest you. In California, (213) 539-9140.

Circle 176 on inquiry card.

Listing 2b continued:

```
                MIXED    EQU  $C053
                PAGE1    EQU  $C054
                HGR      EQU  $C057
                STATUS   EQU  $C08E
                DATA     EQU  $C08F
                PRBLNK   EQU  $F948
                PRHEX    EQU  $FDE3
                *
                TBUFFER  EQU  $3000
                IBUFFER  EQU  $4000
                GRTABLE  EQU  $5000
                *
                SOAKTIME EQU  $300
                SLOTADR  EQU  $302
                ROWSTART EQU  $303
                KEY      EQU  $304
                KEYFLAG  EQU  $305
                INCRMENT EQU  $306
                *
                RADR     EQU  $06
                DEST     EQU  $08
                DEST2    EQU  $1C
                CTR      EQU  $19
                YREG     EQU  $1B
                TMP      EQU  $1E
                COUNT    EQU  $1F
                TABLE    EQU  $EB
                IMAGE    EQU  $ED
                KEEPCNT  EQU  $F9
                KEEPFLG  EQU  $FA
                *
                TEMP1    EQU  $06
                TEMP2    EQU  $07
                TEMP3    EQU  $1C
                TEMP4    EQU  $1D
                TEMP5    EQU  $1B
                *
1000: 4C 09 10           JMP  NORMPIC     ;NORMAL PIC (256X64)
1003: 4C 98 10           JMP  FULLPIC     ;FULL SIZE (256X128 ENHANCED)
1006: 4C 15 11           JMP  GREY        ;GREYSCALE (16 LEVELS OF GREY)
                *
                *
1009: 20 34 12  NORMPIC  JSR  SETGR       ;SET GRAPHICS ON
100C: 20 0A 12  NSTART   JSR  ACIACLR     ;FLUSH THE INPUT BUFFER
100F: A9 D3              LDA  #$D3        ;SEND COMMAND TO SOAK W/O SEND
1011: 20 41 12           JSR  SENDCMD
1014: 20 55 12           JSR  SOAK        ;WAIT EXPOSURE TIME
1017: A9 C0              LDA  #$C0        ;SEND IMAGE W/O SOAK
1019: 20 41 12           JSR  SENDCMD     ;(ALT,WIDEPIX,7BIT-256 X 64)
101C: A2 00              LDX  #0          ;INITIALIZE THE ROW INDEX
101E: A0 00     NEWROW   LDY  #0          ;START NXT ROW, INIT COL INDEX
1020: BD F4 13           LDA  ROWPTR,X    ;GET FIRST ROW ADDRS
1023: 18                 CLC
1024: 6D 03 03           ADC  ROWSTART    ;0-SELECT UPPER 1/3 OF SCREEN
1027: 85 06              STA  RADR        ;$28-MID 1/3, $50-BOT 1/3
1029: E8                 INX              ;RADR HAS ADDRS OF CUR ROW
102A: BD F4 13           LDA  ROWPTR,X
102D: 85 07              STA  RADR+1
102F: E8                 INX              ;POINT X-REG TO NEXT ADDRESS
1030: 84 1B     GET      STY  YREG        ;GET NEXT BYTE FROM CAMERA
1032: AC 02 03           LDY  SLOTADR     ;LOAD OFFSET TO CAMERA SLOT
1035: B9 8E C0           LDA  STATUS,Y    ;CHECK IF NXT BYTE HAS ARRIVED
1038: 4A                 LSR
1039: B0 21              BCS  C15         ;IF BYTE AVAILABLE THEN BRANCH
103B: A9 00              LDA  #0          ;IF BYTE NOT AVAILABLE THEN
103D: 85 19              STA  CTR         ;SET UP TIMEOUT COUNTER
103F: A9 15              LDA  #$15
1041: 85 1A              STA  CTR+1
1043: C6 19     C0       DEC  CTR         ;CHECK FOR BYTE TILL TIMED OUT
1045: D0 0F              BNE  C1
1047: C6 1A              DEC  CTR+1
1049: D0 0B              BNE  C1
104B: AD 30 C0           LDA  BEEP        ;IF TIMED OUT, CLICK SPEAKER
104E: AD 00 C0           LDA  KEYHIT      ;CHECK FOR KEYPRESS
1051: 30 1D              BMI  NDONE       ;IF KEY HIT, RETURN TO BASIC
1053: 4C 0C 10           JMP  NSTART      ;ELSE, RESTART CMD SEQUENCE
1056: B9 8E C0  C1       LDA  STATUS,Y
1059: 4A                 LSR
105A: 90 E7              BCC  C0
105C: B9 8F C0  C15      LDA  DATA,Y      ;WHEN BYTE AVAILABLE GET IT
105F: A4 1B              LDY  YREG        ;RESTORE COL POINTER TO Y-REG
1061: C0 28              CPY  #40         ;IF PAST 40TH BYTE IN CURRENT
```

Listing continued on page 524



Unless you want the best price, performance and quality.

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DISTRIBUTED WORLDWIDE

Circle 228 on inquiry card.

Listing 2b continued:

```
1063: B0 02                 BGE  C3          ;ROW THEN DONT PUT ON SCREEN
1065: 91 06                 STA  (RADR),Y
1067: C8          C3        INY              ;INCREMENT COLUMN POINTER
1068: C0 25                 CPY  #37         ;CHECK FOR END OF COLUMN
106A: D0 C4                 BNE  GET         ;IF NOT, GET THE NEXT BYTE
106C: E0 80                 CPX  #$80        ;CHECK FOR END OF IMAGE
106E: D0 AE                 BNE  NEWROW      ;GOTO NEXT ROW
1070: A9 D1       NDONE     LDA  #$D1
1072: 20 41 12              JSR  SENDCMD     ;REFRESH W/O SENDING
1075: A9 20       DOKEY     LDA  #$20
1077: 8D 04 03              STA  KEY         ;CLEAR 'KEY HIT' VALUE
107A: A9 00                 LDA  #0
107C: 8D 05 03              STA  KEYFLAG     ;CLEAR 'KEY HIT' FLAG
107F: AD 00 C0              LDA  KEYHIT      ;LOOK AT KEYBOARD
1082: 10 13                 BPL  D1          ;BRANCH IF NO KEYPRESS
1084: 2C 10 C0              BIT  KEYCLR      ;CLEAR KEYBOARD STROBE
1087: EE 05 03              INC  KEYFLAG     ;SET 'KEY HIT' FLAG
108A: 8D 04 03              STA  KEY         ;SAVE KEYPRESS
108D: C9 D1                 CMP  #"Q"        ;CHECK IF 'Q' HIT
108F: D0 06                 BNE  D1          ;IF NOT, RETURN
1091: 20 1C 12              JSR  GRCLR       ;CLEAR GRAPHICS SCREEN
1094: AD 51 C0              LDA  TMODE       ;SET TEXT MODE
1097: 60          D1        RTS              ;RETURN TO BASIC
                  *
1098: 20 34 12    FULLPIC   JSR  SETGR       ;SET GRAPHICS ON
109B: 20 A7 10              JSR  TAKEPIC     ;TAKE A PICTURE
109E: 20 83 12              JSR  MOVE        ;MOVE TO CORRECT BUFFER
10A1: 20 A3 12              JSR  DISPLAY     ;TRANS IMAGE TO HIRES SCREEN
10A4: 4C 75 10              JMP  DOKEY       ;CHECK FOR KEYPRESS
                  *
10A7: 20 0A 12    TAKEPIC   JSR  ACIACLR     ;CLEAR ACIA
10AA: A9 FB       START     LDA  #$FB
10AC: 20 41 12              JSR  SENDCMD     ;TELL CAMERA TO SOAK W/O SEND
10AF: 20 55 12              JSR  SOAK        ;WAIT EXPOSURE TIME
10B2: A9 E8                 LDA  #$E8        ;TELL CAMERA TO SEND IMAGE
10B4: 20 41 12              JSR  SENDCMD     ;(NOALT,WIDEPIX,8BIT-512X128)
10B7: A9 00                 LDA  #<IBUFFER   ;SET UP BUFFER ADDRESS
10B9: 85 06                 STA  RADR
10BB: A9 40                 LDA  #>IBUFFER
10BD: 85 07                 STA  RADR+1
10BF: A9 20                 LDA  #$20        ;INIT KEEP COUNTER
10C1: 85 F9                 STA  KEEPCNT
10C3: A9 01                 LDA  #$01        ;INIT KEEP FLAH
10C5: 85 FA                 STA  KEEPFLG
10C7: A0 00                 LDY  #0
10C9: AE 02 03              LDX  SLOTADR     ;GET SLOT ADDRESS
10CC: A9 00       GSTAT     LDA  #0
10CE: 85 19                 STA  CTR         ;SETUP TIMER FOR TIMEOUT
10D0: BD 8E C0              LDA  STATUS,X    ;CHECK IF BYTE READY
10D3: 4A                    LSR
10D4: C6 19                 DEC  CTR         ;LOOP UNTIL CHAR AVAIL
10D6: D0 06                 BNE  NOHANG      ;OR TIMED OUT
10D8: AD 30 C0              LDA  BEEP        ;IF TIMED OUT, CLICK & RESTART
10DB: 4C AA 10              JMP  START
10DE: 90 EC       NOHANG    BCC  GSTAT
10E0: A5 FA                 LDA  KEEPFLG     ;KEEP OR DISCARD?
10E2: F0 08                 BEQ  IGNORE
10E4: BD 8F C0              LDA  DATA,X      ;GET BYTE
10E7: 91 06                 STA  (RADR),Y    ;STORE BYTE IN BUFFER
10E9: 4C EF 10              JMP  CONT
10EC: BD 8F C0    IGNORE    LDA  DATA,X      ;GET BYTE, BUT DISCARD
10EF: C6 F9       CONT      DEC  KEEPCNT     ;DECREMENT COUNTER
10F1: D0 0A                 BNE  CONT1
10F3: A9 20                 LDA  #$20        ;INIT COUNTER
10F5: 85 F9                 STA  KEEPCNT
10F7: A5 FA                 LDA  KEEPFLG
10F9: 49 01                 EOR  #$01        ;TOGGLE KEEP FLAG
10FB: 85 FA                 STA  KEEPFLG
10FD: A5 FA       CONT1     LDA  KEEPFLG     ;CHECK KEEP FLAG
10FF: F0 CB                 BEQ  GSTAT       ;IF IGNORING, DONT INCR PNTRS
1101: C8                    INY              ;INCREMENT POINTER LO
1102: D0 C8                 BNE  GSTAT
1104: E6 07                 INC  RADR+1      ;INCREMENT POINTER HI
1106: A5 07                 LDA  RADR+1
1108: C9 50                 CMP  #$50        ;CHECK IF DONE
110A: D0 C0                 BNE  GSTAT       ;GET NEXT BYTE
110C: A9 F9                 LDA  #$F9        ;TELL CAMERA REFRESH W/O SEND
110E: 20 41 12              JSR  SENDCMD
1111: 20 F2 12              JSR  ENHANCE     ;ENHANCE IMAGE
1114: 60                    RTS
                  *
```

Listing continued on page 526

Listing 2b continued:

```
1115: A9 00    GREY      LDA #<GRTABLE  ;INIT TABLE POINTERS
1117: 85 EB              STA TABLE
1119: A9 50              LDA #>GRTABLE
111B: 85 EC              STA TABLE+1
111D: A0 00              LDY #$00
111F: 98       CLR1      TYA            ;CLEAR GREYSCALE COUNTER TABLE
1120: 91 EB              STA (TABLE),Y
1122: E6 EB              INC TABLE
1124: D0 F9              BNE CLR1
1126: E6 EC              INC TABLE+1
1128: A9 90              LDA #>GRTABLE+$4000
112A: C5 EC              CMP TABLE+1    ;CHECK FOR END
112C: D0 F1              BNE CLR1
112E: A9 0F              LDA #$0F       ;INIT EXPOSURE COUNTER
1130: 85 1F              STA COUNT
1132: A5 1F    NEXTPIC   LDA COUNT
1134: 20 E3 FD           JSR PRHEX      ;DISPLAY COUNT FOR COUNTDOWN
1137: 20 48 F9           JSR PRBLNK     ;LEAVE THREE SPACES
113A: 20 A7 10           JSR TAKEPIC    ;TAKE A PICTURE
113D: A9 00              LDA #<GRTABLE  ;INIT TABLE AND BUFFER PNTRS
113F: 85 ED              STA IMAGE
1141: 85 EB              STA TABLE
1143: A9 30              LDA #>TBUFFER
1145: 85 EE              STA IMAGE+1
1147: A9 50              LDA #>GRTABLE
1149: 85 EC              STA TABLE+1
114B: A0 00              LDY #$00
114D: A2 04    NXTBYTE   LDX #$04
114F: B1 ED              LDA (IMAGE),Y  ;GET NEXT BYTE
1151: 85 1E              STA TMP
1153: 06 1E    LOADTBL   ASL TMP        ;TEST EACH BIT IN THE BYTE
1155: A9 00              LDA #$00
1157: 90 02              BCC ZERO
1159: A9 01              LDA #$01
115B: 06 1E    ZERO      ASL TMP
115D: 90 03              BCC ZERO1
115F: 18                 CLC
1160: 69 10              ADC #$10
1162: 18       ZERO1     CLC
1163: 71 EB              ADC (TABLE),Y  ;AND INCR APPROPRIATE CNTRS
1165: 91 EB              STA (TABLE),Y  ;(TWO BIT-COUNTERS PER BYTE)
1167: E6 EB              INC TABLE      ;INCREMENT TABLE POINTER
1169: D0 02              BNE TBL1
116B: E6 EC              INC TABLE+1
116D: CA       TBL1      DEX            ;DONE WITH THIS BYTE?
116E: D0 E3              BNE LOADTBL
1170: E6 ED              INC IMAGE      ;INCREMENT BUFFER POINTER
1172: D0 D9              BNE NXTBYTE
1174: E6 EE              INC IMAGE+1
1176: A9 40              LDA #>TBUFFER+$1000
1178: C5 EE              CMP IMAGE+1    ;CHECK FOR END OF BUFFER
117A: D0 D1              BNE NXTBYTE    ;IF NOT, GET NEXT BYTE
117C: 18                 CLC
117D: AD 00 03           LDA SOAKTIME
1180: 6D 06 03           ADC INCRMENT   ;INCREMENT EXPOSURE TIME FOR
1183: 8D 00 03           STA SOAKTIME   ;NEXT EXPOSYRE
1186: AD 01 03           LDA SOAKTIME+1
1189: 69 00              ADC #$00
118B: 8D 01 03           STA SOAKTIME+1
118E: C6 1F              DEC COUNT      ;DONE WITH 15 EXPOSURES?
1190: D0 A0              BNE NEXTPIC    ;IF NOT, TAKE NEXT PICTURE
                *
1192: A9 00              LDA #<GRTABLE  ;INIT TABLE AND BUFFER PNTRS
1194: 85 EB              STA TABLE
1196: 85 ED              STA IMAGE
1198: A9 50              LDA #>GRTABLE
119A: 85 EC              STA TABLE+1
119C: A9 40              LDA #>IBUFFER
119E: 85 EE              STA IMAGE+1
11A0: A2 00              LDX #$00
11A2: A9 20    NEXTROW   LDA #$20
11A4: 85 1F              STA COUNT      ;INIT COLUMN COUNTER
11A6: A0 00    THISROW   LDY #$00
11A8: 84 1E              STY TMP
11AA: A9 02              LDA #$02
11AC: 85 19              STA CTR        ;INIT BIT COUNTER
11AE: B1 EB    THISBYTE  LDA (TABLE),Y  ;GET NEXT BYTE
11B0: 29 0F              AND #$0F       ;MASK OFF TOP NIBBLE
11B2: DD E4 13           CMP VAL1,X     ;COMP WITH DITHER MATRX VAL
11B5: 26 1E              ROL TMP        ;ROTATE CARRY BIT INTO BYTE
11B7: B1 EB              LDA (TABLE),Y  ;GET BYTE AGAIN
11B9: 29 F0              AND #$F0       ;MASK OFF LOWER NIBBLE
11BB: DD E8 13           CMP VAL2,X     ;COMP WITH NEXT MATRX VALUE
```

Listing continued on page 528

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Circle 4 on inquiry card.

Listing 2b continued:

```
11BE: 26 1E              ROL  TMP         ;ROTATE CARRY BIT INTO BYTE
11C0: C8                 INY              ;INCR TABLE INDEX
11C1: B1 EB              LDA  (TABLE),Y   ;GET NEXT BYTE
11C3: 29 0F              AND  #$0F        ;MASK OFF UPPER NIBBLE
11C5: DD EC 13           CMP  VAL3,X      ;COMP WITH THIRD MATRX VALUE
11C8: 26 1E              ROL  TMP         ;ROTATE CARRY INTO BYTE
11CA: B1 EB              LDA  (TABLE),Y   ;GET NEXT BYTE AGAIN
11CC: 29 F0              AND  #$F0        ;MASK OFF LOWER NIBBLE
11CE: DD F0 13           CMP  VAL4,X      ;COMP WITH FOURTH MATRX VALUE
11D1: 26 1E              ROL  TMP         ;ROTATE CARRY INTO BYTE
11D3: C8                 INY              ;INCR TABLE INDEX
11D4: C6 19              DEC  CTR         ;DECR BIT COUNTER
11D6: D0 D6              BNE  THISBYTE    ;CONTINUE WITH THIS BYTE
11D8: A0 00              LDY  #$00
11DA: A5 1E              LDA  TMP         ;GET BYTE FOR NXT COL IN IMAGE
11DC: 91 ED              STA  (IMAGE),Y   ;PUT INTO IMAGE BUFFER
11DE: 18                 CLC
11DF: A9 04              LDA  #$04
11E1: 65 EB              ADC  TABLE       ;INCR TABLE POINTER
11E3: 85 EB              STA  TABLE
11E5: 90 02              BCC  NEXT
11E7: E6 EC              INC  TABLE+1
11E9: E6 ED     NEXT     INC  IMAGE       ;INCR BUFFER POINTER
11EB: D0 08              BNE  NXT1
11ED: E6 EE              INC  IMAGE+1
11EF: A5 EE              LDA  IMAGE+1
11F1: C9 50              CMP  #>IBUFFER+$1000 ;CHECK FOR END OF IMAGE
11F3: B0 0E              BGE  DONE
11F5: C6 1F     NXT1     DEC  COUNT       ;IF NOT, DECR COL COUNTER
11F7: D0 AD              BNE  THISROW     ;IF NOT END, STAY ON THIS ROW
11F9: E8                 INX              ;INCR DITHER MATRX INDEX
11FA: E0 04              CPX  #$04
11FC: D0 02              BNE  NXT2
11FE: A2 00              LDX  #$00        ;IF REACHED 4, RESET TO 0
1200: 4C A2 11  NXT2     JMP  NEXTROW     ;DO NEXT ROW
1203: 20 1C 12  DONE     JSR  GRCLR       ;CLEAR GRAPHICS SCREEN
1206: 20 A3 12           JSR  DISPLAY     ;SEND IMAGE TO SCREEN
1209: 60                 RTS
                *
120A: A9 03     ACIACLR  LDA  #3          ;INIT ACIA
120C: 84 1B              STY  YREG        ;SAVE Y-REG
120E: AC 02 03           LDY  SLOTADR     ;GET CAMERA ADDRESS
1211: 99 8E C0           STA  STATUS,Y
1214: A9 14              LDA  #$14        ;8 BITS,1 START,1 STOP,EXT CLK
1216: 99 8E C0           STA  STATUS,Y
1219: A4 1B              LDY  YREG
121B: 60                 RTS
                *
121C: A2 00     GRCLR    LDX  #0          ;CLEAR GRAPHICS SCREEN
121E: A0 00              LDY  #0
1220: 84 06              STY  RADR
1222: A9 20              LDA  #$20
1224: 85 07              STA  RADR+1
1226: 8A                 TXA
1227: 91 06     CLR2     STA  (RADR),Y
1229: C8                 INY
122A: D0 FB              BNE  CLR2
122C: E6 07              INC  RADR+1
122E: E8                 INX
122F: E0 20              CPX  #$20
1231: D0 F4              BNE  CLR2
1233: 60                 RTS
                *
1234: AD 53 C0  SETGR    LDA  MIXED       ;SET MIXED GRAPHICS & TEXT
1237: AD 57 C0           LDA  HGR         ;SET HIRES
123A: AD 54 C0           LDA  PAGE1       ;SET PAGE 1
123D: AD 50 C0           LDA  GMODE       ;SET GRAPHICS MODE
1240: 60                 RTS
                *
1241: 84 1B     SENDCMD  STY  YREG        ;SAVE Y-REG
1243: AC 02 03           LDY  SLOTADR     ;GET CAMERA ADDRESS
1246: 48                 PHA              ;SAVE A-REG
1247: B9 8E C0  SEND1    LDA  STATUS,Y    ;GET STATUS REGISTER
124A: 29 02              AND  #2          ;CHECK IF READY FOR BYTE
124C: F0 F9              BEQ  SEND1
124E: 68                 PLA              ;RESTORE A-REG
124F: 99 8F C0           STA  DATA,Y      ;SEND COMMAND
1252: A4 1B              LDY  YREG        ;RESTORE Y-REG
1254: 60                 RTS
                *
1255: AD 01 03  SOAK     LDA  SOAKTIME+1 ;LOAD COUNTER WITH SOAKTIME
1258: 85 1A              STA  CTR+1       ;  BY SOAKTIME
125A: E6 1A              INC  CTR+1
```

Listing continued on page 530



THE MICRO COMPUTER BUSINESS WILL GROW FROM $10 TO $100 BILLION IN THE NEXT EIGHT YEARS! ARE YOU READY TO CASH IN?

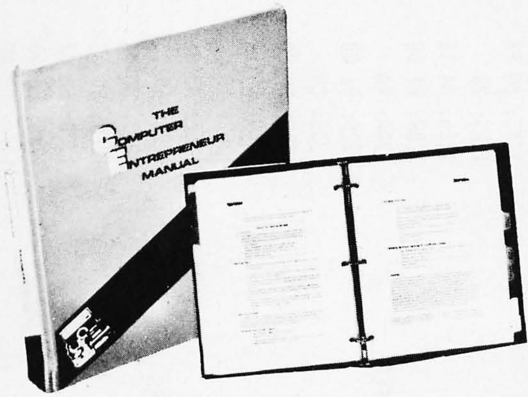
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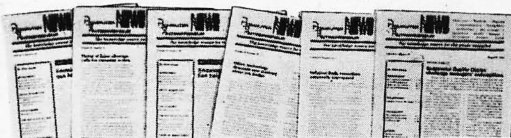
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Circle 108 on inquiry card.

Listing 2b continued:

```
125C: AD 00 03          LDA  SOAKTIME
125F: 85 19             STA  CTR
1261: E6 19             INC  CTR
1263: AD 00 03          LDA  SOAKTIME   ;CHECK FOR ZERO SOAKTIME
1266: D0 05             BNE  SOAK1
1268: AD 01 03          LDA  SOAKTIME+1
126B: F0 0B             BEQ  SOAK2      ;RETURN IF ZERO
126D: 20 79 12  SOAK1   JSR  MSEC       ;WAIT FOR 1 MS
1270: C6 19             DEC  CTR        ;DECR COUNTER
1272: D0 F9             BNE  SOAK1      ;LOOP IF NOT ZERO
1274: C6 1A             DEC  CTR+1      ;DECR COUNTER HI
1276: D0 F5             BNE  SOAK1      ;LOOP IF NOT DONE
1278: 60        SOAK2   RTS
                *
1279: 84 1B     MSEC    STY  YREG       ;SAVE Y-REG
127B: A0 C7             LDY  #199       ;INIT TIMER
127D: 88        DLY1    DEY             ;DECR TIMER
127E: D0 FD             BNE  DLY1       ;LOOP IF NOT DONE
1280: A4 1B             LDY  YREG       ;RESTORE Y-REG
1282: 60                RTS
                *
1283: A0 00     MOVE    LDY  #$00       ;ZERO INDEX
1285: 84 ED             STY  IMAGE      ;INIT BUFFER POINTERS
1287: 84 08             STY  DEST
1289: A9 30             LDA  #>TBUFFER
128B: 85 EE             STA  IMAGE+1
128D: A9 40             LDA  #>IBUFFER
128F: 85 09             STA  DEST+1
1291: B1 ED     LOOP    LDA  (IMAGE),Y  ;GET BYTE FROM TEMP BUFFER
1293: 91 08             STA  (DEST),Y   ;PUT INTO INPUT BUFFER
1295: C8                INY             ;INCR INDEX
1296: D0 F9             BNE  LOOP       ;LOOP IF NOT ZERO
1298: E6 EE             INC  IMAGE+1    ;INCR POINTERS
129A: E6 09             INC  DEST+1
129C: A9 50             LDA  #>IBUFFER+$1000
129E: C5 09             CMP  DEST+1     ;CHECK FOR END OF BUFFERS
12A0: D0 EF             BNE  LOOP       ;LOOP IF NOT DONE
12A2: 60                RTS
                *
12A3: A2 00     DISPLAY LDX  #$00
12A5: A9 00             LDA  #<IBUFFER  ;INIT BUFFER POINTERS
12A7: 85 06             STA  RADR
12A9: A9 40             LDA  #>IBUFFER
12AB: 85 07             STA  RADR+1
12AD: BD F4 13  NXTROW  LDA  ROWPTR,X   ;GET STARTING ADDRS OF CUR ROW
12B0: 85 08             STA  DEST       ;PUT IN SCREEN POINTER
12B2: E8                INX             ;INCR INDEX
12B3: BD F4 13          LDA  ROWPTR,X   ;GET UPPER HALF OF ADDRESS
12B6: 85 09             STA  DEST+1     ;PUT IN SCREEN POINTER
12B8: E8                INX             ;INCR INDEX
12B9: A0 20             LDY  #$20       ;INIT COLUMN COUNTER
12BB: B1 06     MOV     LDA  (RADR),Y   ;GET BYTE FROM BUFFER
12BD: 88                DEY             ;DECR COL COUNTER
12BE: 91 08             STA  (DEST),Y   ;PUT BYTE ON SCREEN
12C0: C0 00             CPY  #0         ;CHECK IF COUNTER IS ZERO
12C2: D0 F7             BNE  MOV        ;IF NOT, DO NEXT BYTE
12C4: A0 00             LDY  #0
12C6: 08        RESHFT  PHP             ;ROTATE EACH BYTE IN ROW SO
12C7: 84 1E             STY  TMP        ;THE HIGH BIT IS CARRIED TO
12C9: B1 08     SHFT    LDA  (DEST),Y   ;THE NEXT BYTE
12CB: 28                PLP
12CC: 2A                ROL
12CD: 91 08             STA  (DEST),Y
12CF: 08                PHP
12D0: C8                INY
12D1: C0 20             CPY  #$20
12D3: D0 F4             BNE  SHFT
12D5: 28                PLP
12D6: A4 1E             LDY  TMP
12D8: B1 08             LDA  (DEST),Y   ;SHIFT THE LEADING BYTE SO THE
12DA: 4A                LSR             ;TOP BIT IS ZERO
12DB: 91 08             STA  (DEST),Y
12DD: C8                INY
12DE: C0 20             CPY  #$20       ;IF NOT DONE, ROTATE ALL OF
12E0: D0 E4             BNE  RESHFT     ;ROW AFTER LEADING BYTE AGAIN
12E2: 18                CLC
12E3: A5 06             LDA  RADR
12E5: 69 20             ADC  #$20
12E7: 85 06             STA  RADR
12E9: 90 02             BCC  DISP1
12EB: E6 07             INC  RADR+1
12ED: E0 00     DISP1   CPX  #0         ;IF SCRN NOT DONE, DO NXT ROW
12EF: D0 BC             BNE  NXTROW
```

Listing continued on page 532

Listing 2b continued:

```
12F1: 60                  RTS
                *
                ******************************************************
                * ENHANCE REARRANGES THE IMAGE IN IBUFFER TO AN
                * IMAGE IN TBUFFER THAT CORRESPONDS MORE
                * PRECISELY TO THE ACTUAL PICTURE BEING SEEN
                * BY THE CAMERA.
                * THE ALGORITHM REARRANGES EACH BYTE AS FOLLOWS:
                *  FOR BYTES IN EVEN ROWS(STARTING WITH ROW 0) --
                *    BITS 2 AND 6 ARE UNCHANGED
                *    BIT 0 MOVES TO BIT 3 OF THE BYTE 1 NEXT ROW
                *    BIT 4 MOVES TO BIT 7 OF THE BYTE 1 NEXT ROW
                *
                *  FOR BYTES IN ODD ROWS --
                *    BITS 0 AND 4 ARE UNCHANGED
                *    BIT 2 MOVES TO BIT 5 OF THIS BYTE IN NEXT ROW
                *    BIT 6 MOVES TO BIT 1 OF THIS BYTE+1 IN NEXT ROW
                ******************************************************
                *
12F2: A9 DF     ENHANCE   LDA  #<IBUFFER-$21 ;INIT BUFFER POINTERS
12F4: 85 06               STA  RADR
12F6: 85 08               STA  DEST
12F8: A9 3F               LDA  #>IBUFFER-$21
12FA: 85 07               STA  RADR+1
12FC: A9 2F               LDA  #>TBUFFER-$21
12FE: 85 09               STA  DEST+1
1300: A9 20               LDA  #$20
1302: 85 1E               STA  TMP
1304: A0 01     NEVEN     LDY  #1            ;PERFORM OPERATION AS DESCR
1306: B1 06               LDA  (RADR),Y      ;ABOVE ON EVEN ROWS
1308: 0A                  ASL
1309: 0A                  ASL
130A: 0A                  ASL
130B: 09 DF               ORA  #$DF
130D: 85 1C               STA  DEST2
130F: 88                  DEY
1310: B1 06               LDA  (RADR),Y
1312: 2A                  ROL
1313: 2A                  ROL
1314: 2A                  ROL
1315: 09 FD               ORA  #$FD
1317: 85 1D               STA  DEST2+1
1319: A0 21               LDY  #$21
131B: B1 06               LDA  (RADR),Y
131D: 09 BB               ORA  #$BB
131F: 29 FF               AND  #$FF
1321: 25 1C               AND  DEST2
1323: 25 1D               AND  DEST2+1
1325: 91 08               STA  (DEST),Y
1327: E6 06               INC  RADR
1329: E6 08               INC  DEST
132B: D0 04               BNE  NODUB
132D: E6 07               INC  RADR+1
132F: E6 09               INC  DEST+1
1331: C6 1E     NODUB     DEC  TMP
1333: D0 CF               BNE  NEVEN
1335: A9 20               LDA  #$20
1337: 85 1E               STA  TMP
1339: A0 01     NODD      LDY  #1            ;PERFORM OPERATIONS AS DESCR
133B: B1 06               LDA  (RADR),Y      ;ABOVE ON ODD ROWS
133D: 0A                  ASL
133E: 0A                  ASL
133F: 0A                  ASL
1340: 09 77               ORA  #$77
1342: 85 1C               STA  DEST2
1344: A0 21               LDY  #$21
1346: B1 06               LDA  (RADR),Y
1348: 09 EE               ORA  #$EE
134A: 29 FF               AND  #$FF
134C: 25 1C               AND  DEST2
134E: 91 08               STA  (DEST),Y
1350: E6 06               INC  RADR
1352: E6 08               INC  DEST
1354: D0 04               BNE  NODUB2
1356: E6 07               INC  RADR+1
1358: E6 09               INC  DEST+1
135A: C6 1E     NODUB2    DEC  TMP
135C: D0 DB               BNE  NODD
135E: A9 20               LDA  #$20
1360: 85 1E               STA  TMP
1362: A5 08               LDA  DEST
1364: C9 DF               CMP  #<TBUFFER+$FDF ;CHECK FOR END OF BUFFER
1366: D0 09               BNE  NEVENJ
1368: A5 09               LDA  DEST+1
136A: C9 3F               CMP  #>TBUFFER+$FDF
```

Listing continued on page 534

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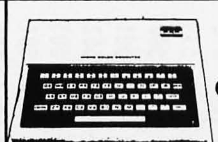
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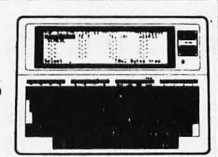
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Listing 2b continued:

```
136C: D0 03           BNE  NEVENJ
136E: 4C 74 13        JMP  FILLIN
1371: 4C 04 13 NEVENJ JMP  NEVEN      ;LOOP IF NOT DONE
               *
               ********************************************************
               * FILLIN COLORS HOLES IN THE IMAGE IN TBUFFER
               * EITHER BLACK OR WHITE, DEPENDING ON THE COLORS
               * OF THE SURROUNDING PIXELS.
               * THE ALGORITHM USED IS AS FOLLOWS:
               *  FOR BYTES IN EVEN ROWS (STARTING WITH ROW 0)--
               *    BITS 0,3,4,7 ARE 'HOLES'
               *    BITS 2 AND 6 ARE UNCHANGED
               *    BIT 5 COMES FROM BIT 2 OF THE BYTE 1 ROW PREV
               *    BIT 1 COMES FROM BIT 6 OF THE BYTE 1 ROW
               *         PREVIOUS LESS ONE BYTE
               *
               *  FOR BYTES IN ODD ROWS--
               *    BITS 1,2,5,6 ARE 'HOLES
               *    BITS 0 AND 4 ARE UNCHANGED
               *    BITS 3 AND 7 COME FROM BITS 0 AND 4 OF THE
               *         BYTE 1 ROW PREVIOUS
               ********************************************************
               *
1374: A9 E0    FILLIN LDA  #<TBUFFER-$20 ;INIT BUFFER POINTER
1376: 85 08           STA  DEST
1378: A9 2F           LDA  #>TBUFFER-$20
137A: 85 09           STA  DEST+1
137C: A2 00           LDX  #0
137E: A9 20           LDA  #$20
1380: 85 1E           STA  TMP
1382: A0 00    FILL1  LDY  #0         ;FILLIN EACH ROW AS
1384: B1 08           LDA  (DEST),Y   ;DESCRIBED ABOVE
1386: 85 07           STA  TEMP2
1388: A0 40           LDY  #$40
138A: B1 08           LDA  (DEST),Y
138C: 85 1C           STA  TEMP3
138E: 25 07           AND  TEMP2
1390: 85 06           STA  TEMP1
1392: A0 20           LDY  #$20
1394: B1 08           LDA  (DEST),Y
1396: 4A              LSR
1397: 1D E0 13        ORA  RMASK,X
139A: 05 06           ORA  TEMP1
139C: 85 1D           STA  TEMP4
139E: B1 08           LDA  (DEST),Y
13A0: 0A              ASL
13A1: 1D E2 13        ORA  LMASK,X
13A4: 05 06           ORA  TEMP1
13A6: 85 1B           STA  TEMP5
13A8: A5 07           LDA  TEMP2
13AA: 05 1C           ORA  TEMP3
13AC: 1D DE 13        ORA  CMASK,X
13AF: 31 08           AND  (DEST),Y
13B1: 25 1D           AND  TEMP4
13B3: 25 1B           AND  TEMP5
13B5: 91 08           STA  (DEST),Y
13B7: E6 08           INC  DEST
13B9: D0 08           BNE  FILL2
13BB: E6 09           INC  DEST+1
13BD: A9 40           LDA  #>TBUFFER+$1000
13BF: C5 09           CMP  DEST+1     ;CHECK FOR END OF BUFFER
13C1: F0 0F           BEQ  FILL3
13C3: C6 1E    FILL2  DEC  TMP
13C5: D0 BB           BNE  FILL1
13C7: A9 20           LDA  #$20
13C9: 85 1E           STA  TMP
13CB: 8A              TXA
13CC: 49 01           EOR  #1
13CE: AA              TAX
13CF: 4C 82 13        JMP  FILL1
13D2: A2 1F    FILL3  LDX  #$1F
13D4: BD 40 30 CLEAN  LDA  TBUFFER+$40,X ;CLEAN UP THE FIRST ROW
13D7: 9D 00 30        STA  TBUFFER,X
13DA: CA              DEX
13DB: 10 F7           BPL  CLEAN
13DD: 60              RTS
               *
13DE: 66 99    CMASK  DFB  $66,$99
13E0: EE BB    RMASK  DFB  $EE,$BB
13E2: 77 DD    LMASK  DFB  $77,$DD
13E4: 01 0D 04
13E7: 0F       VAL1   DFB  $01,$0D,$04,$0F
13E8: 90 50 C0
13EB: 80       VAL2   DFB  $90,$50,$C0,$80
```

Listing continued on page 536

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Listing 2b continued:

```
13EC: 03 0F 02
13EF: 0E        595  VAL3    DFB  $03,$0F,$02,$0E
13F0: B0 70 A0
13F3: 60        596  VAL4    DFB  $B0,$70,$A0,$60
                597  *
                598  ********************
13F4: 00 20 00
13F7: 24 00 28
13FA: 00 2C 00
13FD: 30 00 34
1400: 00 38 00
1403: 3C        599  ROWPTR  HEX  002000240028002C003000340038003C
1404: 80 20 80
1407: 24 80 28
140A: 80 2C 80
140D: 30 80 34
1410: 80 38 80
1413: 3C        600          HEX  802080248028802C803080348038803C
1414: 00 21 00
1417: 25 00 29
141A: 00 2D 00
141D: 31 00 35
1420: 00 39 00
1423: 3D        601          HEX  002100250029002D003100350039003D
1424: 80 21 80
1427: 25 80 29
142A: 80 2D 80
142D: 31 80 35
1430: 80 39 80
1433: 3D        602          HEX  802180258029802D803180358039803D
1434: 00 22 00
1437: 26 00 2A
143A: 00 2E 00
143D: 32 00 36
1440: 00 3A 00
1443: 3E        603          HEX  00220026002A002E00320036003A003E
1444: 80 22 80
1447: 26 80 2A
144A: 80 2E 80
144D: 32 80 36
1450: 80 3A 80
1453: 3E        604          HEX  80228026802A802E80328036803A803E
1454: 00 23 00
1457: 27 00 2B
145A: 00 2F 00
145D: 33 00 37
1460: 00 3B 00
1463: 3F        605          HEX  00230027002B002F00330037003B003F
1464: 80 23 80
1467: 27 80 2B
146A: 80 2F 80
146D: 33 80 37
1470: 80 3B 80
1473: 3F        606          HEX  80238027802B802F80338037803B803F
1474: 28 20 28
1477: 24 28 28
147A: 28 2C 28
147D: 30 28 34
1480: 28 38 28
1483: 3C        607          HEX  282028242828282C283028342838283C
1484: A8 20 A8
1487: 24 A8 28
148A: A8 2C A8
148D: 30 A8 34
1490: A8 38 A8
1493: 3C        608          HEX  A820A824A828A82CA830A834A838A83C
1494: 28 21 28
1497: 25 28 29
149A: 28 2D 28
149D: 31 28 35
14A0: 28 39 28
14A3: 3D        609          HEX  282128252829282D283128352839283D
14A4: A8 21 A8
14A7: 25 A8 29
14AA: A8 2D A8
14AD: 31 A8 35
14B0: A8 39 A8
14B3: 3D        610          HEX  A821A825A829A82DA831A835A839A83D
14B4: 28 22 28
14B7: 26 28 2A
14BA: 28 2E 28
14BD: 32 28 36
14C0: 28 3A 28
14C3: 3E        611          HEX  28222826282A282E28322836283A283E
14C4: A8 22 A8
14C7: 26 A8 2A
```

Listing continued on page 538

Never again worry about computer theft or damage

What could be better than full replacement?

By now, you've probably heard or read about SAFEWARE℠ Insurance for microcomputers. But you may still wonder just what it protects, or whether it's really worth the investment. If you've never lost any part of your computer system or software, you probably don't yet realize the limitations of most standard insurance coverages. Or the agonies you could face in trying to recover even the simplest piece of peripheral equipment.

What do you mean it's not covered?!

Operating your computer system without SAFEWARE protection is fine as long as you don't have to worry about an accident or loss. But what if you came home one night to discover you'd been robbed? Or that a pipe had burst and caused water damage? Or that your system, too, had fallen victim to a leading destroyer of microsystems—a power surge? All events beyond your control. If something like this should happen to you, you're likely to find out the hard way just how limited your standard insurance policy's protection really is. And no matter how little or how much you have invested in your computer system, discovering that it's not covered can be an expensive lesson.

Now you can be sure

SAFEWARE was developed by an insurance professional who was shocked to learn that his very own personal computer was at risk. Can you imagine? What he discovered was that his homeowners insurance policy excluded coverage as soon as he began operating his first business program. Even his simplest spreadsheet voided coverage. Because most homeowners policies *won't cover any equipment used for business,* no matter how infrequently. Out of this need was born SAFEWARE. A simple, easy-to-understand coverage you can count on. Full replacement coverage of hardware, software and media, after a low $50 deductible.

With SAFEWARE there's no need for you to schedule equipment or software as you do with the "rider" type of policies. So your coverage can grow with your system, providing protection for its full value rather than each individual item. This will be especially important to you if you're ever planning to buy additional equipment or software. Even just one peripheral.

What the editors are saying

Desktop Computing: . . . "Given the amount of money that business users spend on computer equipment . . . it's not too farfetched to say that an insurance policy may be the most important new accessory that you could add to your desktop computer system."

Computer Decisions: . . . "Your personal computer might not be safe at home. If it is not insured, then you're running the risk of losing the thousands of dollars you've invested . . ."

Personal Computing: . . . "Replacing hardware may be more of a problem than you thought it would be . . . That's why (a computer consultant) suggests that you get the computer insured."

Wall Street Journal: . . . "Columbia National General Agency introduces a policy that covers home computers regardless of use. The usual premium: about $75 a year."

An All-Risk, no risk offer

SAFEWARE is an *All-Risk* plan of insurance, which means that it covers *all* hardware, *all* purchased software, and *all* media. Your complete system is protected against theft, fire, accidental damage, even damage sustained while the computer is being transported in your car. SAFEWARE even covers damage caused by power surges . . . the leading destroyer of microcomputers. And, now, SAFEWARE is available on a *no risk* basis. If you are not completely satisfied with the protection afforded by SAFEWARE, you may return the policy for a full refund within the first 10 days after you've received it.

Thousands have said "yes!"

Since it was first introduced in 1982, thousands of computer owners, like you, have said *"yes"* to the SAFEWARE offer. Owners of systems from the smallest portable micros to larger sophisticated business systems are finding that SAFEWARE offers the most affordable and complete security. And the simplest peace of mind available to ensure carefree computing.

The cost: pennies a day

As you can see from the table, the annual premium for a typical system consisting of a $3,000 processor, a disk drive and printer worth $1,100, and $900 in software, is just $60. And you can save even more since the cost of insurance for personal computers used for business may be tax deductible. To determine your rate of coverage, just add up your total system value. Then, find the premium in the table.

Easy to order

Choose from three simple ways to pay for your complete SAFEWARE protection: Call the toll free phone number listed and we'll charge your premium to your VISA or MasterCard. Or, you can mail us your order along with your check. Or, send us the coupon and charge your policy to your credit card.

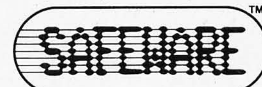
Total Hardware, Media & Software System Value	Annual Premium
Up to $ 2,000	$ 35
$ 2,001-$ 5,000	$ 60
$ 5,001-$ 8,000	$ 75
$ 8,001-$11,000	$ 90
$11,001-$14,000	$105
$14,001-$17,000	$125
$17,001-$21,000	$140
$21,001-$24,000	$155
$24,001-$27,000	$170

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- Ultimate in power surge protection.
- Costs as low as $35 a year.

Yes, my computer needs immediate protection.
Please issue my SAFEWARE Insurance Policy.

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Street ______________________

City ______________________

State ________ Zip ____________

System value $ ______________

☐ Check Enclosed ☐ VISA
☐ MasterCard

Card # ______________________

Exp. Date ______________________

No risk. You may return policy for full refund within 10 days. Coverages and limits are subject to the terms, conditions and exclusions in the policy.

Mail to: SAFEWARE, P.O. Box 02211, Columbus, OH 43202
BYT

Circle 408 on inquiry card.

Listing 2b continued:

```
14CA: A8 2E A8
14CD: 32 A8 36
14D0: A8 3A A8
14D3: 3E        612          HEX  A822A826A82AA82EA832A836A83AA83E
14D4: 28 23 28
14D7: 27 28 2B
14DA: 28 2F 28
14DD: 33 28 37
14E0: 28 3B 28
14E3: 3F        613          HEX  28232827282B282F28332837283B283F
14E4: A8 23 A8
14E7: 27 A8 2B
14EA: A8 2F A8
14ED: 33 A8 37
14F0: A8 3B A8
14F3: 3F        614          HEX  A823A827A82BA82FA833A837A83BA83F


--END ASSEMBLY--

ERRORS: 0

1268 BYTES

SYMBOL TABLE - ALPHABETICAL ORDER:

   ACIACLR =$120A     BEEP    =$C030     C0      =$1043     C1      =$1056
   C15     =$105C     C3      =$1067     CLEAN   =$13D4     CLR1    =$111F
   CLR2    =$1227     CMASK   =$13DE     CONT    =$10EF     CONT1   =$10FD
   COUNT   =$1F       CTR     =$19       D1      =$1097     DATA    =$C08F
   DEST    =$08       DEST2   =$1C       DISP1   =$12ED     DISPLAY =$12A3
   DLY1    =$127D     DOKEY   =$1075     DONE    =$1203     ENHANCE =$12F2
   FILL1   =$1382     FILL2   =$13C3     FILL3   =$13D2     FILLIN  =$1374
   FULLPIC =$1098     GET     =$1030     GMODE   =$C050     GRCLR   =$121C
   GREY    =$1115     GRTABLE =$5000     GSTAT   =$10CC     HGR     =$C057
   IBUFFER =$4000     IGNORE  =$10EC     IMAGE   =$ED       INCRMENT=$0306
   KEEPCNT =$F9       KEEPFLG =$FA       KEY     =$0304     KEYCLR  =$C010
   KEYFLAG =$0305     KEYHIT  =$C000     LMASK   =$13E2     LOADTBL =$1153
   LOOP    =$1291     MIXED   =$C053     MOV     =$12BB     MOVE    =$1283
   MSEC    =$1279     NDONE   =$1070     NEVEN   =$1304     NEVENJ  =$1371
   NEWROW  =$101E     NEXT    =$11E9     NEXTPIC =$1132     NEXTROW =$11A2
   NODD    =$1339     NODUB   =$1331     NODUB2  =$135A     NOHANG  =$10DE
   NORMPIC =$1009     NSTART  =$100C     NXT1    =$11F5     NXT2    =$1200
   NXTBYTE =$114D     NXTROW  =$12AD     PAGE1   =$C054     PRBLNK  =$F948
   PRHEX   =$FDE3     RADR    =$06       RESHFT  =$12C6     RMASK   =$13E0
   ROWPTR  =$13F4     ROWSTART=$0303     SEND1   =$1247     SENDCMD =$1241
   SETGR   =$1234     SHFT    =$12C9     SLOTADR =$0302     SOAK    =$1255
   SOAK1   =$126D     SOAK2   =$1278     SOAKTIME=$0300     START   =$10AA
   STATUS  =$C08E     TABLE   =$EB       TAKEPIC =$10A7     TBL1    =$116D
   TBUFFER =$3000     TEMP1   =$06       TEMP2   =$07       TEMP3   =$1C
   TEMP4   =$1D       TEMP5   =$1B       THISBYTE=$11AE     THISROW =$11A6
   TMODE   =$C051     TMP     =$1E       VAL1    =$13E4     VAL2    =$13E8
   VAL3    =$13EC     VAL4    =$13F0     YREG    =$1B       ZERO    =$115B
   ZERO1   =$1162

SYMBOL TABLE - NUMERICAL ORDER:

   RADR    =$06       TEMP1   =$06       TEMP2   =$07       DEST    =$08
   CTR     =$19       YREG    =$1B       TEMP5   =$1B       DEST2   =$1C
   TEMP3   =$1C       TEMP4   =$1D       TMP     =$1E       COUNT   =$1F
   TABLE   =$EB       IMAGE   =$ED       KEEPCNT =$F9       KEEPFLG =$FA
   SOAKTIME=$0300     SLOTADR =$0302     ROWSTART=$0303     KEY     =$0304
   KEYFLAG =$0305     INCRMENT=$0306     NORMPIC =$1009     NSTART  =$100C
   NEWROW  =$101E     GET     =$1030     C0      =$1043     C1      =$1056
   C15     =$105C     C3      =$1067     NDONE   =$1070     DOKEY   =$1075
   D1      =$1097     FULLPIC =$1098     TAKEPIC =$10A7     START   =$10AA
   GSTAT   =$10CC     NOHANG  =$10DE     IGNORE  =$10EC     CONT    =$10EF
   CONT1   =$10FD     GREY    =$1115     CLR1    =$111F     NEXTPIC =$1132
   NXTBYTE =$114D     LOADTBL =$1153     ZERO    =$115B     ZERO1   =$1162
   TBL1    =$116D     NEXTROW =$11A2     THISROW =$11A6     THISBYTE=$11AE
   NEXT    =$11E9     NXT1    =$11F5     NXT2    =$1200     DONE    =$1203
   ACIACLR =$120A     GRCLR   =$121C     CLR2    =$1227     SETGR   =$1234
   SENDCMD =$1241     SEND1   =$1247     SOAK    =$1255     SOAK1   =$126D
   SOAK2   =$1278     MSEC    =$1279     DLY1    =$127D     MOVE    =$1283
   LOOP    =$1291     DISPLAY =$12A3     NXTROW  =$12AD     MOV     =$12BB
   RESHFT  =$12C6     SHFT    =$12C9     DISP1   =$12ED     ENHANCE =$12F2
   NEVEN   =$1304     NODUB   =$1331     NODD    =$1339     NODUB2  =$135A
   NEVENJ  =$1371     FILLIN  =$1374     FILL1   =$1382     FILL2   =$13C3
   FILL3   =$13D2     CLEAN   =$13D4     CMASK   =$13DE     RMASK   =$13E0
   LMASK   =$13E2     VAL1    =$13E4     VAL2    =$13E8     VAL3    =$13EC
   VAL4    =$13F0     ROWPTR  =$13F4     TBUFFER =$3000     IBUFFER =$4000
   GRTABLE =$5000     KEYHIT  =$C000     KEYCLR  =$C010     BEEP    =$C030
   GMODE   =$C050     TMODE   =$C051     MIXED   =$C053     PAGE1   =$C054
   HGR     =$C057     STATUS  =$C08E     DATA    =$C08F     PRBLNK  =$F948
   PRHEX   =$FDE3
```



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Remarkably, the new $599 Transtar 120 is "plug and go" compatible with the best-selling word processing programs. Just plug the 120 into your personal computer and watch this precision printer purr along at 14 cps Shannon text speed producing superscript, subscript, underlining and a true boldface. Even using letterhead is now a breeze with the 120's automatic single sheet loading!

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Circle 481 on inquiry card.

User to User

Conducted by Jerry Pournelle

Copy Protection and Privacy

Dear Jerry,

The Superscribe II word processor is distributed by On-Line Systems (now Sierra On-Line Inc.). When I first got it, I found it a fairly good word processor with some very interesting features. For instance, it has a 70-column upper/lower-case display on an unmodified Apple with *software* printer spooling and a keyboard buffer. Not a bad achievement, even with its share of bugs. And On-Line did provide a free backup disk.

Then, last summer, On-Line updated the program to its present Screenwriter II and gave it some enhancements, such as a mouse or joystick. However, it also added a *very* nasty copy-protection system. The company's update policy was $10 for a new disk and a manual with the return of one of the disks. After about two weeks, I got the new disk and manual (a large improvement, I might add). It wouldn't boot, so I took it to a store owned by a friend of mine and tried to boot it on a Franklin with Apple drives, an Apple with Rana drives, and an Apple with a Super-5 and a normal drive. It would not boot on any of them. So off went the disk to the company, and two weeks later I got a new one. It wouldn't boot on any of the machines, either. I called, and the company said to return it again. Being an accomplished programmer, I decided to play around for a while. After spending a few minutes boot-tracing the program, I finally got it to run. However, I simply am not going to boot-trace a program every time I want to run it, which in this case might be two or three times a day. So I found the nibble counts in it and removed them. It then worked on any machine. When I called the company and told a programmer there how to fix this problem, he said (in a very moronic tone), "Oh, uh, I guess we'll fix it" and took my name and address. About three weeks later I started to receive *Softalk* magazines free, with a little "Sponsored by On-Line Systems" on top of the label. Not exactly the correction I had hoped for.

I simply cannot abide by a tool being protected from copying, or in this case just *use*. As a result of the company's screwing around, I lost four weeks of valuable time owing to the loss of the backup. It is absolutely ridiculous to keep someone who relies on a product from copying it. Beyond that, if I wanted to modify it for either of my nonstandard drive configurations, I couldn't because the nibble counts would stop it from functioning; the length and content would be changed.

It is simply not worth buying a product that I can't use to my own ends, provided I don't pirate it, which I wouldn't. It is also interesting to note that a product I subsequently purchased from On-Line (the game Pest Patrol) would not work on my drives, which I had completely checked by a Class I repair center. In light of this, I have decided never to purchase anything from On-Line again and advise anyone who wants products guaranteed to *work* on their Apple system to do likewise.

Douglas Henkin
150 East 77th St.
New York, NY 10021

My late mad friend would have published the company's bit map in retaliation. Companies that destroy their own utility to "prevent piracy" only encourage legitimate hackers to turn pirate. . . . **Jerry**

Dear Jerry,

In your June column ("Zenith Z-100, Epson QX-10, Software Licensing, and the Software Piracy Problem," page 411) you touched on a subject near and dear to my heart, protection. I have three words to say about it: I hate it. I have no objection to copyright; just those protection schemes.

My problems started when I bought a 5-megabyte Corvus hard disk for my Apple IIe. The Corvus drive can only live in slot 6 because of the firmware on the controller card; therefore, the floppy disk must be elsewhere. The first problem I ran into was not being able to put my games, educational and other protected software on the Corvus. The second problem was booting protected software from the floppy disk in slot 7 or elsewhere. Do you realize how much software out there will not work if the floppy-disk controller is not in slot 6? I said to myself, instead of trying to get all software houses in the universe to change their software, why not get Corvus to change its firmware so that it can go in slot 7? Well, after having my dealer call Corvus several times, the company's answer was, "impossible to do." I tried to call the vice-president of the company and never got a return call. High Technology software of Oklahoma City also talked to them. No way, they said.

Back to protection. CP/M software is not protected, and I don't hear them crying about pirates of their software. Beagle Bros. Software is not protected and it is still in business. At least one well-known game house has dropped protection and reduced all of its prices on software for the Apple to $19.95.

Like you said, "For every protection scheme there is somebody out there ready to break it." How can it be stopped? Software programmers, please stop putting those locks on your software. Instead, install a serial number somewhere in the program that is registered to the original owner. That way, if he sells or gives away a copy and the person who gets it needs to send it back to the company for any reason, the serial number can be traced. Finally, have faith and enforce your copyrights. Yes, believe it or not, I think the majority of people out here have integrity and are not out to rip you off.

Stan Epstein
116 S. Cedarwood
Rose Hill, KS 67133

Piracy is a real problem, but most protection schemes cause far more problems than they solve. . . . **Jerry**

What's the Cache?

Dear Jerry,

In your July column ("Interstellar Drives, Osborne Accessories, DEDICATE/32, and Death Valley, page 323), you used the word "cache" to refer to a system that stores frequently used information from a disk in RAM. I thought you might like some background information. I understand that the original use of the word cache in computers had to do with mainframe computers. A mainframe will have a large main memory (say 256K bytes)



Suddenly, personal computers that just stand alone don't stand a chance.

The trouble with most personal computers is that they don't tie into office automation. Maybe that's why they're called "standalones". So instead of bringing the people in your company together, they only succeed in keeping them apart.

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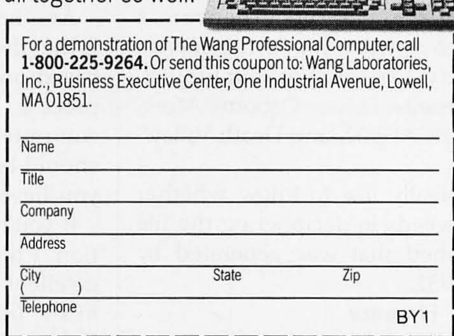
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with access times around 200 to 500 nanoseconds. That's fast enough to keep most microcomputer CPUs happy, but it seems like a long time to a mainframe CPU. So a small amount (say 256K bytes) of fast, expensive cache memory is installed between the CPU and the main memory to hold the frequently used information from the main memory. The access time of the cache memory might be 20 to 50 nanoseconds.

My opinion, for what it's worth, is that disk emulators (or RAM disks) will gradually become obsolete. The 16-bit microcomputers on the market can handle up to about 500K bytes of addressable memory, which is more than you can put on a 5¼-inch disk. Once enough software becomes available to take advantage of all that memory, disk emulators will no longer be needed.

Gerry Ashton
Box 415, Rural Rt. 4
Hopewell Jct., NY 12533

Thanks. Tracy Kidder explains cache well in his The Soul of a New Machine. *You're probably right about disk emulators, but not for a while. They'll last a couple more years, and wow, do they save time! . . .* **Jerry**

Public Key Encryption

Dear Jerry,

Computer systems security is part of my job here at Kodak Park. Therefore, I was quite interested in your comments on public key crypto systems in your July column ("Interstellar Drives, Osborne Accessories, DEDICATE/32, and Death Valley," page 323).

I would really like to know whether anyone succeeds in deciphering the file you published that was generated by DEDICATE/32.

William E. Florance
Security Administrator
Eastman Kodak Co.
Management Services Division
Bldg. 56, Kodak Park
1669 Lake Ave.
Rochester, NY 14650

So far no one has claimed the prize! In fact, only a few admit to having tried. . . . **Jerry**

Dear Jerry,

You hit the nail on the head, sir. The most common mistake I've seen made about encryption schemes is boundless faith in long keys. Although key length is important, it only gives one a rough feel for the resistance of a particular cipher to brute force (i.e., try every key) attacks. A mathematically weak system can be attacked with several analytical tools, assuming the enciphering process is public knowledge. If it isn't, the use of classic cryptoanalytic attack (cribs, etc.) will be the approach of choice.

Incidentally, I seem to recall an article in *Infoworld* late last year that described the successful breaching of the public key system by a mathematician using an Apple II. As I remember, the demonstration was at some kind of convention and (seemingly) was tightly controlled. I wouldn't use the public key system to hide a second set of books, anyhow.

The bottom line is, any cryptosystem is of only hypothetical security value, and some hypotheses are better than others. The major concern I would have in evaluating the merits of any encryption scheme is the sophistication of the opposition and the volume of material to be encrypted. Several old and simple systems are quite secure for enciphering limited amounts of plain text, notably the Playfair cipher and the Jefferson wheel (AKA the Bazeries cylinder). These systems are very easy to implement on the micro and can be worked by hand if need be. The same can hardly be said for the [National Bureau of Standards] Data Encryption Standard, eh?

Another generally held rule of thumb is that the security of a system cannot be based on the secrecy of the encryption process, be it by mechanical device or computer program. The opposition should be presumed to have everything you have, save the key.

If you're interested in further information, I highly recommend David Kahn's excellent book, *The Codebreakers*, a classic in the field of cryptology.

Bob Scott, Lieutenant, U.S. Navy
3095 Marina Dr., Unit -2
Marina, CA 93033

The public key system used by Charlie Merritt is not *the one discussed in* Infoworld. *This one is based on factoring large numbers. My research indicates that it will take the resources of a government to break the Merritt system, and I wouldn't bet that a government can do it. Charlie Merritt has invited any computer wizards who are interested to try to disassemble his program for all the good it's going to do them. . . .* **Jerry**

Europe Replies

Dear Jerry,

From time to time in your column a European standard emerges as a culprit for what-they-did-to-the-Selectric-keyboard on the IBM PC. As you certainly are aware, a disturbing number of languages are spoken in Europe—English, German, French, Spanish, and Italian, for example. For each language there is a traditional keyboard that may or may not have achieved the dignity of a standard. Further, European keyboards differ not only from language to language but also from country to country. The "German" keyboards in West Germany, Austria, Switzerland, and Luxembourg are by no means identical. Surely there must be more to the PC's keyboard than a ghost?

G. Accardo
6225 Hersberg 7
Luxembourg

I know only what the sales and public relations people tell me. At any rate, there are now software fixes, so all's better if not well. . . . **Jerry**

Dear Jerry,

You have commented a couple of times in BYTE on the IBM PC keyboard. For the record, the features of the keyboard you have criticized are all designed in the U.S. and are as American as pie and Watergate. To wit: key placement, key spacing, and so on.

The one keyboard feature that has been influenced by European norms is height, which you have not criticized. There are *no* European keyboards that have a key between the space bar and shift *except* for IBM PC keyboards imported from the U.S. Umlauts sit way above the shift key.

Have you got something against Europe?

V. M. Lorensen
Raiffeisenstr. 1
Seeheim
West Germany

IBM and DEC both said *it was a European standard. Great gobs of goo. . . .* **Jerry**

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THE DISK GOOD ENOUGH TO BE WARRANTED 5 YEARS

Dear Jerry,

You keep harping on about the nasty "European" keyboard supplied with the IBM PC. Sure it's European, and sure it's nasty, but your moans are like complaining that a grapefruit is sour because it's yellow.

So far as I am aware, the "Europeanness" of the IBM keyboard only has to do with ergonomic attributes such as being separate from the rest of the machine and standing low above the table. In much of Europe, this sort of let's-mollycoddle-the-user "standard" gets called "Swedish." Look at the Basis—its keyboard is just as "European/Swedish," yet you said quite nice things about it the other month.

Manufacturers were making such a thing about meeting "Swedish" standards at last fall's Paris office equipment show (SICOB) that a friend of mine was sent to Stockholm to get copies of these "standards." It was like trying to reach the end of the rainbow. It seems that the much-vaunted Swedish ergonomic "standards" are actually stiff demands made by labor unions. All very well, except that they appear to be regulated by union whim.

Each European country has a different typewriter keyboard layout to cope with things such as "être ou pas être, c'est là la question." But that is not what you are complaining about, either: important things, like where to put the big keys, are the same in Europe and in America. It's obvious if you stop to think about it: little typewriter keytops are easy for manufacturers to swap around, but changing the physical locations of the big keys for each country would be uneconomic.

The real bugbear is that many computer manufacturers and programmers do not know how to type in any language. Although IBM makes typewriters, it is noticeable that it was not the typewriter department that produced the PC.

Some programmers' lack of typing ability is astonishing: when I first started word processing on an Exidy Sorcerer, I was flabbergasted by a table of "single keystroke" entries for BASIC keywords—as though a two-key combination such as "graphic-G" could conceivably be easier than typing TAB(, opening parenthesis and all! Clearly the BASIC manual was not directed at word-processing customers.

Many utility programs are just as bad. I find it is easier and quicker to type out short, meaningful command words such as ENTER in full rather than try to remember the current program's one- or two-letter abbreviation, but I've seen competent systems programmers boggle at the prospect of hunting for, and then pecking at, five whole letters in the right order just for one command. Why require five acts where one will do?

You might well do good by castigating neglect of the touch-typist by IBM and the rest of the programming world, but blaming it on Europeans in general, or Swedes in particular, is wide of the mark. By the way, I have no special pro-Sweden axe to grind, and although I live just outside Paris, I'm British.

Andrew Marland
35 Avenue Chevreul
92270 Bois Colombes
France

I don't mean to blame Europeans, but IBM's short-sightedness! They had the best keyboard in the world (Selectric), and they blew it! . . .
Jerry

On Comments

Dear Jerry,

I have a quick comment on your use of comments in a Modula-2 program. I think I can cast some insight on the situation. Your statement that it is clearer if FOR ends with NEXT, and WHILE with WEND, makes sense only in the context of your ongoing enthusiasm for advanced versions of BASIC. However, for someone such as myself, who has never used a BASIC with WEND in it, using WEND to end a loop seems no more natural than using QWERTY. I would suggest commenting your example program thusly:

```
While n<N DO
  FOR i:=1 TO 5 DO
    WriteString("Foo")
  END; (* FOR i *)
  WriteString("Fiddle");
  DEC(N);
END; (* WHILE n<N *)
```

Using comments that indicate the loop variables allows the reader to simply look upward from the comment until he finds the loop statement with the same variables. With your method, all he can do is *hope* to find the corresponding WHILE statement. For nested WHILEs in particular, simply putting WEND won't do the job. Note that this affords the same ease of reading that NEXT I (rather than just NEXT) does. But bringing in NEXT is unnecessary, as is WEND.

As for your columns, they are always provocative and informative, even if I don't always agree. Keep it up.

Matt Richards
815-C Dartmouth Rd.
Baltimore, MD 21212

Seems like a good idea. Meanwhile, Modula-2 remains my favorite language. . . .
Jerry

Z-100 Notes

Dear Jerry,

Poverty drove me to the Heath version of the Z-100. It is relatively easy to assemble and very well documented. One needs to be light of touch with a soldering iron on the controller board, but otherwise the kit is within the skill level of the average tinkerer. My unit came on line after only about 10 hours of effort.

I must also report that one of the claims made in the advertising is significantly overstated. The 8-inch drives that you connected up so easily must have been double-sided, for it seems that only double-sided drives will work with this machine. That was a serious blow to me because the ability to use my old drives was the economic cornerstone of my decision to launch this project.

I have called Heath to ask whether a single-sided drive can be made to work, but after the first contact, which revealed that a BIOS patch was available, the help came to an end. You would be surprised at how long Heath technicians can hold their breath on the phone! It's hard to believe that they think they will sell too many of the $2700 disk drives using this tactic when equivalent drive systems are available for less than half that price on the open market.

Jerry, if your technical friends come up with a way to make Shugart 800 drives work with the Z-100, I'd surely like to hear about it.

Colin Evans
150 Walnut St.
Stratford, CT 06497

Others also report that the Heathkit version of the Z-100 is easy to build. I'm glad you were happy with yours.

Alas, I know of no way to use single-sided

drives; mine are indeed double-sided (Compupro), and I never did check for single. Sorry.

We use the Z-100 primarily with 5¼-inch disks, but we like the ability to transfer to 8-inch disks easily.

If anyone writes with a simple way to use single-sided 8-inch drives, I'll be sure to put it in the column. . . . **Jerry**

Dear Jerry,

I finished assembling the Heathkit version of the Z-100 in March. I'm writing to tell you how to fix Zorro's squeaky keyboard. I also think that the squeak is needless on such a fine keyboard. Further, a blinking cursor makes me want to kill. I have spent sleepless nights developing horrible tortures for engineers that think I need the cursor to blink blink blink blink blink blink blink blink blink blink blink blink at me while I'm trying to think.

I've enclosed the listing of MODE.COM, which stops the squeak and the blink. The program is a minor modification of the one on page P.5 of volume 2 of the Z-DOS manual. The program could be further modified to reset anything on the machine by changing the MESG line. I've put MODE.COM into the AUTOEXEC.BAT file.

About the Heathkit H-100—it is incredibly easy to assemble. At $2199 you are stealing this computer. Except for the disk controller board there are only two solder joints in the entire project! If you don't like to solder you can farm out the controller to a friend you trust with a soldering iron. Pay him $100, and you still save $900 over the price of the Z-100. I built the main box in less than five hours. The controller took me about 10 hours to solder, but I had no experience and was working very carefully.

Reinhard Koch
1500 Cloverdale Ave.
Winston-Salem, NC 27104

Thanks—that helps a lot! I don't much care for blinks, either. . . . **Jerry**

Jerry Pournelle welcomes readers' comments and opinions. Send a self-addressed envelope to Jerry Pournelle, c/o BYTE Publications, POB 372, Hancock, NH 03449. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply.

Listing 1: *The MODE.COM listing, which stops the squeak and the blink in the Heathkit version of the Z-100.*

```
type mode.asm


        TITLE   'MODE.COM' — SET UP MACHINE THE WAY I LIKE IT
        PAGE    ,132

        .XLIST
INCLUDE DEFASCII.ASM
INCLUDE DEFMS.ASM
        .LIST

PGMSEG  SEGMENT
        ASSUME  CS:PGMSEG,SS:PGMSEG,DS:PGMSEG,ES:NOTHING
        ORG     100H                ; Position after program header
START:
        MOV     DX,OFFSET MESG      ; GET ADDR OF MESSAGE
        MOV     AH,DOSF_OUTSTR      ; GET FUNCTION TO OUTPUT MESSAGE
        INT     DOSI_FUNC           ; PRINT MESSAGE
        INT     DOSI_TERM           ; STOP PROGRAM
                ;ESC,BLINK CRSR OFF,ESC,KEY-SOUND OFF,CR,LF,END-CHAR
MESG    DB      27,'x;',27,'x2',13,10,'$'

PGMSEG  ENDS
        END     START

; As shown on page P.5 of the Z-DOS manual, create a COM file by entering:
;
;                       MASM MODE;
;                       LINK MODE;
;                       EXE2BIN MODE.EXE.COM
;                       ERASE MODE.EXE
;
; You now have MODE.COM.

B:
```

Ask BYTE

Conducted by Steve Ciarcia

Joystick for the PC

Dear Steve,

I would like to build the joysticks for my IBM Personal Computer using Radio Shack's joystick potentiometer, Catalog No. 271-1705. Can you tell me how to wire up the potentiometer? The IBM manuals have been no help. Also, I hooked up a 13-inch Hitachi color television set to the IBM PC, but I get poor resolution in the 80-character by 25-line mode. Any suggestions?

Robert Smith
Darien, CT

Adapting the Radio Shack joystick potentiometer to the IBM Personal Computer is easy (see figure 1). Of course, your PC will need a joystick interface card. Also, while the value of the 271-1705 joystick is rated at 100K ohms, the 30-degree travel of the joystick handle may limit the range that can be controlled. If this is a problem, a potentiometer with a larger resistance will be needed. The total resistance change should be around 100K ohms.

*The signal bandwidth of a color television is too narrow for an 80-character line to be displayed clearly. The only solution for sharp characters is to use a high-bandwidth (greater than 12 MHz) monitor. . . .***Steve**

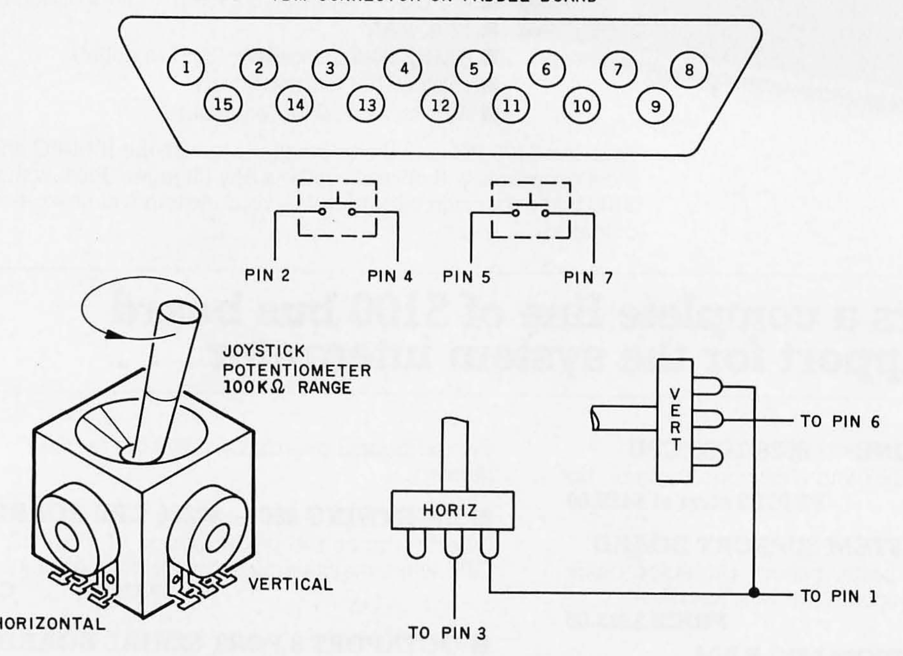


Figure 1: *The technical specifications needed to employ a 100K-ohm joystick potentiometer as a joystick for an IBM Personal Computer.*

Atari 800 to VCS

Dear Steve,

I own an Atari 800 and am interested in making cartridges for the Atari VCS or 5200. Do the VCS and 5200 both use a 6502 chip? If they do, is it possible to use standard Atari assembly language for programming? If they do not use the 6502—or are not compatible with Atari assembly language—can you tell me if there is any other way to make cartridges for the VCS or 5200? (I understand that there is a board that lets you use an Apple II Plus for this purpose.) Any help will be greatly appreciated.

Scott Brause
Edison, NJ

The Atari 800 and the Atari VCS both use a 6502-type microprocessor and share the same machine language. It is therefore possible to develop games on your Atari 800 that will run on a VCS.

The boards for the Apple II Plus are made by

Frobco
POB 8378
Santa Cruz, CA 95061
(408) 429-1551

*These units are real-time development systems consisting of a plug-in board for the Apple II and EPROM plug-in boards for the VCS or 5200. . . .***Steve**

Apple Disk Information

Dear Steve,

I would appreciate your help in finding sources of information about the operation (hardware and software) of the Apple II disk drives and disk-drive controllers.

Robert Kao
West Linn, OR

One of the best references on the operation of the Apple disk operating system is the book Beneath Apple DOS *by Don Worth and Pieter Lechner. Published by Quality Software, it is available at most computer stores. The book completely describes the DOS software and explains the disk formatting. Because many of the disk-drive functions are software controlled rather than hardware controlled, you will be off to a good start.*

The Apple disk controller schematic on page 145 of the Apple DOS Manual *shows that it does little more than turn the drive on and off, move the stepper motor, and translate the disk pulses into a 6-bit hexadecimal code. The software that drives the controller is explained in* Beneath Apple DOS. *The disk analog card features the MC3470 read amplifier, which takes the differential AC signal from the disk's read/write head and converts it to a digital output pulse. It is amplified and filtered, sent to the controller for translation, and then sent to the data bus. . . .***Steve**

The Monitor and the Merriment

Dear Steve,

I have been using a BMC 13-inch color monitor with two home computers: a Commodore VIC-20 and a TI-99/4A. I also have another computer (built from an NRI kit) that is based on an

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Businesses will appreciate spoken data transmission, narration of graphic displays and unmanned, oral product demonstrations. Spoken verification of data input will make computers much easier for the blind to use. School children can receive comprehensive computer instruction with voice textbooks as well as spoken drills and testing. And then, late at night, you can make those adventure games explode.

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- ☐ 255 programmable frequencies for speech/sound effects.
- ☐ 16 amplitude levels.
- ☐ Simultaneous speech and sound effects or speech and music.
- ☐ 8 octave, 3 note music synthesis.
- ☐ Serial and parallel interface standard.
- ☐ User programmable master clock.
- ☐ User defined exception word table.
- ☐ User programmable speech rate, amplitude and inflection.
- ☐ User expandable ROM for custom applications.
- ☐ User downloadable software capability.
- ☐ 3,500 character input buffer: subdivisible for a printer buffer.
- ☐ Internal speaker and external speaker jack.
- ☐ Real time clock and 8 user defined alarms.
- ☐ Oral power up and error prompting.
- ☐ X-on/X-off and RTS-CTS handshaking.
- ☐ Programmable Baud settings (75-9600).
- ☐ Interrupt driven Z-80 microprocessor.
- ☐ Parallel/Serial interconnect modes.
- ☐ Proper number string translation: the number "154" is pronounced "one hundred fifty four".

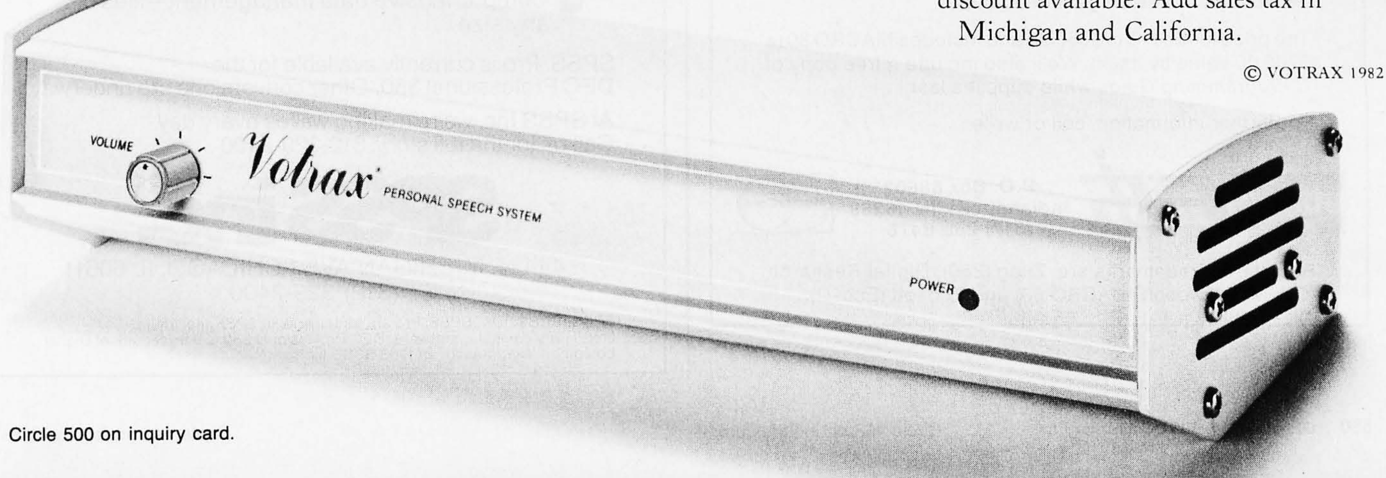
To order, see your local computer retailer or call toll-free

1-800-521-1350

Michigan residents, please call (313) 588-0341. MasterCard, VISA or personal check accepted. The price is $395 plus $4 for delivery. Educational discount available. Add sales tax in Michigan and California.

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Circle 500 on inquiry card.

MC6802 microprocessor. This unit has memory-mapped video, uses an MC6670 character generator, and displays 24 lines of 32 characters on a television screen. How can I get it to display to my monitor?

Itshak Mihaeli
Brooklyn, NY

Your color monitor is designed to accept a composite video signal directly. A television receiver is designed to accept a composite video signal that is superimposed onto a radio-frequency (RF) carrier. Most low-cost computers, such as your NRI, provide the video output on an RF carrier (usually channel 3 or 4) to enable a home television set to be used as a monitor.

*The VIC-20 and the TI-99/4A have a direct video output that is not modulated to a television channel. Their output can therefore be displayed directly on your monitor. The RF signal from your NRI system is preventing the video signal from being displayed. If you tap into the composite video signal inside the computer before it goes into the RF modulator, you will be able to display its output on your monitor. . . .***Steve**

Power-line Warning

Dear Steve,

I am about to receive a Victor 9000 system and would appreciate some information on a gadget that gives warning of power-line failures and glitches. Despite considerable searching, I have been unable to find the name or manufacturer of this minor piece of equipment and its price (though I understand that its cost is not high). Can you help?

Brian Rushton
Brooklyn, NY

The device for indicating power-line failure and glitch occurrence, the Glitch Sentinel, is manufactured by

BMI Billings McEachern Inc.
402 Lincoln Centre Dr.
Foster City, CA 94404
(415) 570-5355

The Glitch Sentinel features indicator lights for a variety of power-line conditions including high and low line frequency, voltage spikes, and "noise." At $400 to $975 (with printer) per unit, I do not consider this a "minor piece of equipment" and suggest that you may be confusing this product with one of the many devices available that suppress surges and glitches. . . . **Steve**

Greek Character Set

Dear Steve,

I have both a Commodore PET 2001 and a VIC-20 and would like to find a character generator for both that will display the Greek character set.

Dafni Voulgaridou
Thessaloniki, Greece

Two programmable character generators for the PET have been advertised within the last year. The first, the ICT Programmable Character Generator, is available from

Micro Mini Computer World
74 Robinwood Ave.
Columbus, OH 43213

It allows the user to reprogram any of the PET's 256 standard screen characters and would certainly allow the use of Greek characters.

The other unit is manufactured by

Systems Formulate Corporation
39 Town & Country Village
Palo Alto, CA 94301

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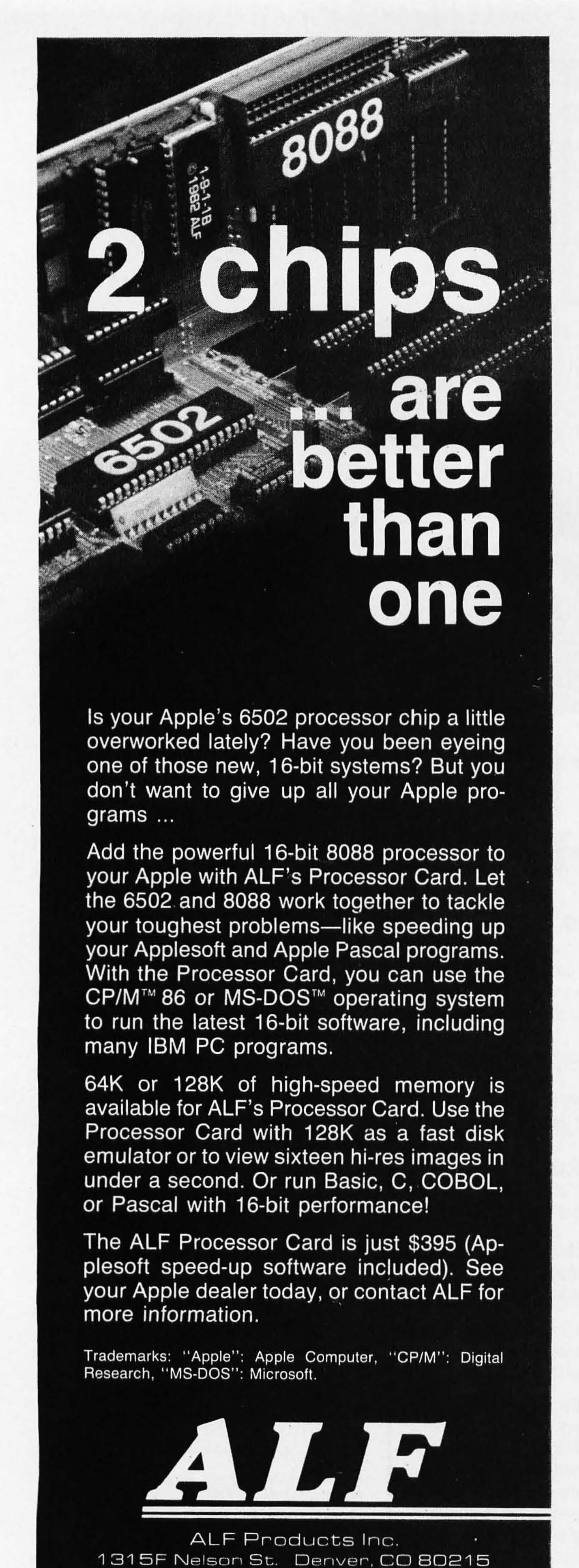
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OR CALL: (800) 323-3629, In Illinois call (312) 981-9200



Another device, the Soft ROM, consists of a board that plugs into your character generator's ROM socket and provides 4K bytes of RAM to create a customized character generator. An alternate character set can then be loaded into this RAM and switched. This card is available for $129 from

Canadian Micro Distributors Ltd.
365 Main St.
Milton, Ontario L9T 1P7,
Canada

A foreign-language ROM for Commodore systems is available from

Kobetek Systems Ltd.
Rural Route #1
Wolfville, Nova Scotia
B0P 1X0, Canada
(902) 678-7771

You should contact them for specific information.

Also, I refer you to an article on creating custom character sets for the VIC-20 computer. This article, "Pixelator" (Compute!, *October 1982), shows how to obtain an alternate character set. The principles can also be applied to the PET. . . .***Steve**

Pascal Primers

Dear Steve,

I am trying to learn Pascal and need a good book to help me. There are many Pascal books on the market, but I don't know which would be suitable for me. I have been using BASIC for over three years, so I'm not exactly a beginner with micros or software. Can you recommend an appropriate book for me?

James Smith
Pinellas Park, FL

Many excellent books on Pascal programming are available, but I will list three that may be of special interest to you.

Pascal from BASIC *by Peter Brown (BYTE/McGraw-Hill) emphasizes the advantages of structured programming and presents the concepts required to adapt Pascal to your computer. It builds on your previously acquired BASIC skills.*

Introduction to Pascal *by James Welsh and John Elder (Prentice-Hall) provides short, illustrative programs and a series of 17 case studies. It is written for the beginning programmer.*

If you own an Apple II computer, an excellent book is Apple Pascal—A Hands-on Approach *by Arthur Luehrmann and Herbert Peckham (McGraw-Hill). This is a tutorial guide to Apple Pascal designed to be used with an Apple II. . . .***Steve**

CP/M on an Elf

Dear Steve,

I have an expanded version of the Elf II 1802-based computer with 64K bytes of RAM, an ASCII keyboard, and Level III BASIC. How can I run CP/M on this system? Can a Z80-based computer be interfaced with the Elf system to use its RAM and other accessories?

Barry Dyar
APO New York

CP/M was written for an 8080 microprocessor and it will also run on 8085 and Z80 chips, but it cannot be directly implemented on an 1802. However, a Z80 microprocessor could be interfaced to the Elf's bus (similar to Microsoft's Z80 card for the Apple II) to use existing memory and I/O ports. CP/M could then run on this hybrid system. I have never tried this combination and am not aware of any commercially available boards to accomplish it. You might try writing to

 Circle 25 on inquiry card.

Netronics R&D Ltd.
333 Litchfield Rd.
New Milford, CT 06776

This company sells the Elf II and has CP/M on its Explorer/85 system. Perhaps it has worked out a combination of the two. . . . **Steve**

E-Z Does It

Dear Steve,

I was very impressed with your E-Z Color Graphics Interface (BYTE Circuit Cellar, August 1982), but I feel that designing it for the Apple is like bringing coals to Newcastle. The article stated that an S-100 version was being planned; I have long felt that S-100 systems needed such a board for good games and graphics programs. Do you think that it would be feasible to combine the graphics support of the E-Z Color board with a sound generator and a joystick/paddle interface on an S-100 board?

My S-100 system has only one slot available at the present. Is there any way that I can increase the number of slots available? What I had in mind was something analogous to an extension cord with multiple outlets.

David Langan
Lafayette, LA

The S-100 version of the E-Z Color board features the TMS 9918A sprite graphics, an SN76489A sound-generator circuit (BYTE Circuit Cellar, July 1982), and an input port capable of reading two Atari joysticks. It's available from

Micromint Inc.
561 Willow Ave.
Cedarhurst, NY 11516
(800) 645-3479

Your idea of expanding the S-100 bus with "an extension cord with multiple outlets" is sound if the connecting cable is not too long and if the original socket had buffered address and data lines. Active or passive termination of the bus is recommended if the length is more than several inches. (See also Ask BYTE, August 1983, page 486.) . . . . **Steve**

BSR X-10 Revisited

I have occasionally referred to the BSR X-10 Home Control System in my articles and recently (BYTE Circuit Cellar, July 1983) described my disillusionment with the X-10. The following is part of a letter from John Dilday at Leviton Manufacturing Company that helps shed some light on this subject.

"My experience has shown that the arbitrary switching you describe is caused by legitimate X-10 signals. The culprit is your ultrasonic controller and other similar "early consumer" transmitters. You will find that controllers with the buttons floating at 125 volts line potential are sensitive to power-line transients or electrical noise. Noise occurring as the controller chip is scanning the buttons can activate a controller just as if you had intentionally pressed a button. You can demonstrate this to yourself by monitoring the transmit LED. Whenever it flashes without an intentional command, it is transmitting as commanded by the power-line noise.

"There are several solutions to your arbitrary switching experience. One is to eliminate the sensitive controllers from your system and replace them with Leviton's Central Control System devices that are not sensitive to noise. Another is to disconnect these controllers whenever they are not being used to actually transmit a signal. If you must leave the sensitive controllers on line, installing 0.02=μF glass capacitors from each of pins 16-23 to ground has been found a satisfactory remedy.

"The X-10 signal standard is one that can be reliable. It requires a specific combination of events to activate a receiver: (1) a 121-kHz signal, (2) a signal coordinated with zero-crossing, (3) the proper 9-bit code for a specific device, and (4) the complement of the 9 bits. This signal standard results in a system that can be made to operate reliably on three-phase 277/480 volts down to your single-phase 240-volt home electrical system, or even a low-voltage twisted pair." ■

In "Ask BYTE," Steve Ciarcia answers questions on any area of microcomputing. The most representative questions received each month will be answered and published. Do you have a nagging problem? Send your inquiry to:
Ask BYTE
c/o Steve Ciarcia
POB 582
Glastonbury, CT 06033
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It was a hard way to get what you needed. A year that earned you an honorary degree in computer engineering and the status of a computer buff.

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So, we've taken a different approach to making and selling our Kaypro II. Rather than a starter system, with options you buy piece for piece, it's designed with all the integrated hardware and software it needs to be fully functional.

Off the shelf, Kaypro II is completely ready for business. We think that's what the first-time buyer really needs.

IT'S A COMPLETELY INTEGRATED SYSTEM.

Since we don't consider a monitor, disk drives, interfaces or other hardware as optional extras, all Kaypro's hardware comes complete in an integrated system. Except, of course, for a printer. As you know, some people don't need one. And those who do must decide whether they need dot matrix or letter quality printing.

What's complete on a Kaypro II?

64K RAM, Z-80 microprocessor. A 9" green screen monitor. Dual disk drives, the same used by IBM. A detachable keyboard that's more complete than you'll find on the latest Apple. Built-in interfaces for both a printer and communications.

In other words, all the hardware you'd recommend to a first-time buyer. In one complete package.

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While businesses can be very different, the fact is that 95% of all business needs can be fulfilled by a series of three business applications programs. Word Processing/Spelling, Data Base Management and Financial Spreadsheeting.

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PERFECT FILER
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PROFIT PLAN

But it too comes complete with a Kaypro.

And with its CP/M operating system, Kaypro II is capable of running thousands of other business programs, to fill more specialized needs.

IT SELLS FOR $1595, COMPLETE.

People are bound to ask you how much they should spend on a computer. There is, of course, an obvious answer: as little as possible and still get a serious business system, complete with all the functions they need.

At $1595, Kaypro II is the least expensive serious business system we know of on the market today.

There are basic starter systems advertised for less. But their optional hardware and software can double or triple their basic price. So they can end up costing $2000-$3000 more than a Kaypro.

A good example is an Apple IIe. With a hardware configuration comparable to Kaypro II's, complete with comparable software, it lists for an average price of $4400. $2805 more than a Kaypro.

IT OFFERS MORE MEMORY FOR THE MONEY.

Since disk drive memory capacity is always a concern, once again the idea is to get the most for the money. With two disk drives, Kaypro II gives you 400K for $1595. With equivalent hardware, an IBM gives you 320K for about $2800. And Apple IIe gives you 286K for about $2400.

So once again, Kaypro II delivers.

IT HAS POWER TO SPARE FOR WHAT MOST BUSINESSES NEED.

The more you love computers, the more tempting it is to recommend a 16-bit vs. 8-bit machine. You know that 16-bit systems are a little faster and have more power to run longer programs.

However, 16-bitters are far more expensive than the 8-bit variety. And, unfortunately, have only a handful of business applications software packages that really take advantage of them.

SPECIFICATIONS

Microprocessor
Z-80
Operating System
CP/M 2.2
User Memory
64K
Disk Drives:
2 drives, 400K, unformatted
Interfaces
1 Serial
1 Parallel
Keyboard
Detached, 63-key with numeric keypad
Software included:
Perfect Writer word processing
Perfect Speller
Perfect Filer
Perfect Calc spreadsheet
Wordstar word processing
The Word Plus
Profit Plan spreadsheet
M-Basic
12 Games
Uniform—allows computer to 'read' and 'write' TRS-80, Osborne, Xerox disks
Dimensions
Height: 8 inches
Width: 18 inches
Depth: 15½ inches
Weight: 26 lbs. (portable)

Considering the real needs and budget limitations of most small businesses, why suggest a company limo when a good company car will do?

Since 75% of all micros sold today are 8-bit systems, it's indicative of their capacity to take care of business. We'd stick with a Kaypro II.

IT CAN PAY FOR ITSELF FASTER THAN MORE EXPENSIVE COMPUTERS.

Every business person wants a computer to pay for itself in increased productivity. And the faster the better. Perhaps on this count alone, Kaypro II is worth recommending.

As a fully functional business system for $1595, Kaypro can win the payout race hands down.

IT'S BECOME A LEADING SELLER THANKS TO COMPUTER BUFFS, LIKE YOU.

In fact, Kaypro II is one of the best sellers in the $1000-$5000 price range. And it got there largely because of the enthusiastic word of mouth, and word of press, of computer enthusiasts. Many of whom, after building their own systems, bought a Kaypro II as their second computer.

So you certainly won't be alone if you recommend Kaypro II to anyone shopping for a first computer.

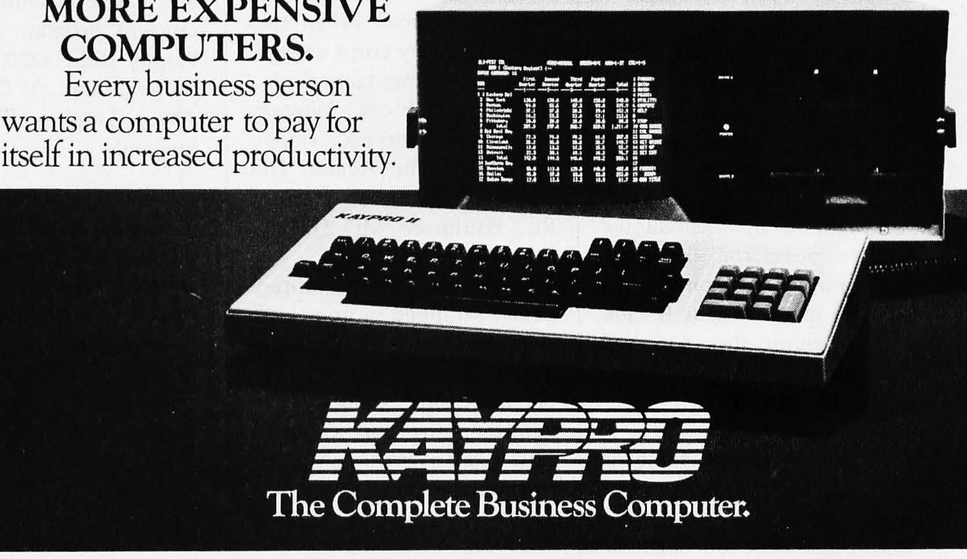
Or look at it this way. Once you tell people about the complete business computer for $1595, they'll probably stop bugging you with a lot of questions.

They may even forget to ask why you didn't buy a Kaypro II for yourself.

Just between us buffs, we can't recommend a good answer for that.

CALL 800-447-4700 FOR THE DEALER NEAREST YOU.

Circle 540 on inquiry card.



Software Received

Apple

Bookends, a reference-management system that keeps track of information from articles, books, and magazines alphabetically using authors and keywords. This program offers storage and retrieval. For II Plus, IIe, and III; floppy disk, $124.95. Sensible Software Inc., 6619 Perham Dr., West Bloomfield, MI 48033.

The Chambers of Vocab, an educational game that builds vocabulary skills. Your goal is to work your way up and out of the Chambers of Vocab by demonstrating vocabulary skills. Up to four players can choose from three difficulty levels. For II, II Plus, and IIe; floppy disk, $48.96. Reader's Digest Services Inc., Pleasantville, NY 10570.

The Cheap Assembler, a menu-driven, interactive editor/assembler system that lets you edit, assemble, list, and execute 6502 assembly-language programs without leaving the system. The program includes editor commands, assemble-time error messages, and assembler syntax. For II Plus and IIe; floppy disk, $23.50. Thunder Software, POB 31501, Houston, TX 77231.

Home Investment Package, a series of three sections: the stock-tracking program, the compound-interest program (for any account that offers a compounded interest), and the main menu, which allows you to move from the stock program to the compound-interest program. For II Plus and IIe; floppy disk, $15. Yes Software, 220 McKee Ave., Oxford, OH 45056.

Pensate, a thinking game of evasion. The object is to get to the top of an 8 by 8 grid while avoiding other playing pieces. All ages can play. For the II Plus; floppy disk, $19.95. Penguin Software, 830 4th Ave., Geneva, IL 60134.

Tactical Armor Command, a game simulation of World War II in which you pick a nation, build a combat team from powerful tanks, assault guns, and tank destroyers, and command the team you've created against the enemy. For II, II Plus, and IIe; floppy disk, $40. The Avalon Hill Game Co., 4517 Harford Rd., Baltimore, MD 21214.

Ultimaker II, a game program that allows **Ultima II** players to boost their character's abilities and print maps of many areas of the game. It also includes a program of playing hints that you use at your discretion. For II and II Plus; floppy disk, $14. Amazing Software, 625 Wellington St. N, London, Ontario N6H 3E8, Canada.

Atari

Paris in Danger, a multilevel simulation game of the December 1814 campaign to crush Napoleon. When two or more enemy corps engage, combat becomes tactical on a strategic map of Western Europe. For the 800; floppy disk, $35. The Avalon Hill Game Co., 4517 Harford Rd., Baltimore, MD 21214.

Solar Storm, an adventure game. Strapped in your laser ship, you must battle fierce aliens that approach in waves of increasing velocity. In addition, the sun explodes and showers heated fragments on your vulnerable planet. See if you can survive. For the 2600; cartridge, $29.95. Imagic, 981 University Ave., Los Gatos, CA 95030.

CP/M

Fallout, a fallout-prediction and shelter-design program that lets you analyze any location in North America under various attack scenarios and size a shelter for the location. This program includes an accessible database of over 1200 targets, 300 weather stations, multiple targeting, user-selectable attack cases and winds, and easy-to-understand summary outputs. Floppy disk, $29.95. Go Software, POB 2693, Chicago, IL 60690.

Organizer II, a utility package that lets you display, explain, and execute hundreds of applications, utilities, and system functions. You can also develop your own special menus. Floppy disk, $149. The Information People, 443 Hudson Ave., Newark, OH 43055.

Pro Pascal, a programming-language compiler that generates native machine code for efficient program execution. Floppy disk, £220. Prospero Software Ltd., 37 Gwendolen Ave., London SW15 6EP England.

Z80ASM, a Z80 assembler in manual form with complete source-code listing and a tutorial on assembler theory. Includes standard Zilog mnemonics and manual. Easily revised as a cross-assembler. Floppy disk, $50. King Software, POB 208, Red Bank, NJ 07701.

Commodore

Casual Writer, a utility package that lets your computer function like a word processor. No need to retype your entire text, just retype those words you need to change. Information can be stored on tape and easily recalled from tape for quick review. For the VIC-20; cassette, $29. E.N. Publications, RR 1, Box V, Worden, IL 62097.

Deadly Skies, a fast-action arcade game. You must destroy the enemy's military base, missile emplacements, and many tanks. Avoid patrols, asteroids, and tracking bombs. For the VIC-20; cartridge, $39.95. Tronix, 8295 South La Cienega Blvd., Inglewood, CA 90301.

Dr. Floyd, an interactive game that simulates artificial intelligence. You can converse with this program in the psychoanalytical technique used in client-centered therapy. For the VIC-20; cassette, $14.95. Apropos Technology, Suite 821, 350 North Lantana Ave., Camarillo, CA 93010.

Gold Fever, an arcade-type game. Inside an abandoned gold mine, you must collect all the gold you can before your oxygen runs out. Avoid runaway boxcars, rolling boulders, and an evil claim jumper. For the VIC-20; cartridge, $39.95. Tronix (see address above).

The Math Teacher, an educational math-tutorial program that drills students in math from first grade through junior high school levels. It contains 25 working math problems per session and displays student's scores. For the

COMMODORE 64

Commodore 1701 Color Monitor
14" screen-big screen, high quality-direct connect to 64 & VIC-20
Your LOW Cost:$269.95

Commodore 1525E Printer
Quality dot matrix, direct connect to Com. 64 & VIC-20.
No interface necessary.
Your LOW Cost:$269.95

Commodore Datasette
Includes interface & cable, for use with Com. 64 & VIC-20. Your Cost:$69.95

Commodore 1541 Disk Drive
High quality at low cost, direct connect to Com. 64 & VIC-20.
Your LOW Cost:$299.95

Commodore C1600 Modem
The best deal in the country for a modem-Your LOW Cost:$69.95

Commodore Software Package (30 programs) only $12.95 with the purchase of one of these packages:

COMMODORE 64 $189.95*

COMMODORE 64 Computer–only $189.95*
*when purchased with any of these three packages.

COMMODORE 64 with the purchase of		$189.95
1 1541	Disk Drive	$299.95
1 1525E	Printer	$289.95
	ALL FOR	$779.85

COMMODORE 64 with the purchase of		$189.95
1 1541	Disk Drive	$299.95
1 1701	14" color monitor	$269.95
	ALL FOR	$769.85

COMMODORE 64 with the purchase of		$189.95
1 1541	Disk Drive	$299.95
1 1526	Fast printer-includes IFC/cable direct connect to 64	$349.95
	ALL FOR	$839.85

COMMODORE VIC-20 $74.95*
*with the purchase of

1	Datasette program recorder	$69.95
1	Gortek educational software	$24.95
	All for	$169.85

COMMODORE 4040 Dual Disk Drive
Dual Disk Drive for the 64 & other models
340KB each-total storage 640KB
Come & try them-they're GREAT!
Retail:$1295.00 Y/C:$589.95

30 Programs for less than $30!
Commodore Software Package $29.95

NEW Impact Dot Matrix Printer by "Fidelity" direct connect to VIC 20/Com. 64. 30 cps ribbon cartridge, inc. adapter. Uses 2¼" plain paper tape-does graphics! Y/C:$99.95 (90 day warranty)

DATA 20 Accessories

• Z-80 card	For Commodore 64	$269.95
• 80 column card	For Commodore 64	169.95
• 40 column card	For VIC-20	99.95
• 40 column card	w/8K mem built-in for VIC-20	139.95
• Video Pack 64K	For VIC-20	329.95

*FREE with the purchase of each of the above (*) products–Word Master/word processing software, Mailing List software & Telecommunications software.

IMMEDIATE DELIVERY!

FRANKLIN

FRANKLIN ACE 1000 – APPLE COMPATIBLE!
64K with many more features than Apple! Upper/lower case, typewriter-style keyboard, VisiCalc keys, Built-in fan, 12-key numeric pad & much more!

SPECIAL PACKAGE:
ACE 1000 computer (64K of RAM)
Disk drive w/controller
80 column card
Ace Calc - Spread sheet
Ace Writer - word processing software
12" green monitor
Epson printer or Star Gemini 10X
(Dot matrix printer, current model)
$100 worth of software for Apple (retail $)
Sugg. retail:$2895.00 Y/C:$1699.00

Package Two: Same as Special Package, but with second Vista Disk Drive-Y/C:$1898.00

Package Three: Same as One & Two, but with letter quality printer, instead of dot matrix:

w/Diablo 620		2629.00
w/SCM PTI		2238.00
w/Olivetti Praxis 41	1	2069.00
w/Brother 50		2069.00
w/C. Itoh F 10		2749.00

FRANKLIN PRODUCTS

ACE 1000	749.95
ACE 1200 w/disk drive /controller	1469.95
Vista disk drive w/controller	269.95
Vista drive only	199.95
ACE Top (5)	179.95
ACE 80 CPU card	359.95
ACE display card	179.95
ACE dual interface	199.95
ACE 10 shielded drive cable	19.95
ACE I/O ext cable (5' parallel)	39.95
ACE I/O ext cable (5' Serial)	39.95

DON NOT BUY AN I B M PERSONAL COMPUTER before you see & try the new SANYO MBC 550 Computer which is an IBM PC clone at one-third the price!

The SANYO MBC-550
128K memory (expandable to 256K)
Powerful 16-bit 8088 CPU
160K disk drive (exp. to 640K w/two drives)
High quality, low profile
80-column display
MD/DOS operating system-(the defacto standard of IBM compatibility)
Sanyo BASIC
Word Processing software
Spread sheet (VisiCalc-like) software
and more!
Your cost is NOT $3,000 – $2,000 – or even $1,500
YOUR COST IS $995.95

Optional
128K additional memory
8087 Number Cruncher co-processor
320K drives (2 provides over half a megabyte on line)
Hard disk available soon

Texas Instruments Home Computer

$99.95* TI 99/4A including the $50 TI rebate *(you pay us $149.95)*
The only 16K COLOR computer under $100-16 bit-*FAST!*
Purchase of TI-99/4A includes One Year Full Warranty & 2½ hrs class from TI–also New TI-Hot Line phone number.
FREE with the purchase of any of these TI packages, either Word Processor, MultiPlan or LOGO (one only!)

Package one:
PHP 1250 Disk drive
PHP 1240 Disk controller card
PHP 1200 Peripheral box
PHP 1260 32K expansion card
Sugg. retail:$1199.00 Your cost:$429.95

Package two:
PHP 1250 Disk drive
PHP 1240 Disk controller card
PHP 1200 Peripheral box
Sugg. retail:$999.00 Your cost:$319.95

Package three:
TI 99/4A Computer
PHP 1250 Disk drive
PHP 1240 Disk controller card
PHP 1200 Peripheral expansion box
PHP 1260 32K expansion card
Sugg. retail:$1499.00 Your Cost:$529.95*
(*after TI $50.00 rebate-you pay us $579.95)

Package four:
TI 99/4A Computer
PHP 1250 Disk drive
PHP 1240 Disk controller card
PHP 1200 Peripheral expansion box
Sugg. retail:$1199.00 Your cost:$419.95*
(after TI $50.00 rebate-you pay us $469.95)

Package five:
TI 99/4A Computer
PHP 1250 Disk drive
PHP 1240 Disk controller card
PHP 1200 Peripheral expansion box
PHP 1260 32K expansion card
PHP 2500 Printer (Epson 80)
Sugg. retail:$1799.00 Your cost:$949.00*
(after TI $50.00 rebate-you pay us $999.95)

Package six:
TI 99/4A Computer
PHP 1250 Disk drive
PHP 1240 Disk controller card
PHP 1200 Peripheral expansion box
PHP 1260 32K expansion card
PHP 4100 Color monitor
Sugg. retail:$1699.00 Your cost:$879.95*
(after TI $50.00 rebate-you pay us $929.95)

NEW TI-CC-40 Portable Computer from TEXAS INSTRUMENTS

$189.95

IMMEDIATE DELIVERY

NEW CC-40 Texas Instruments Compact Computer NOW IN STOCK! Don't throw your money away by buying a portable computer at $800 or $1000 the TI CC-40 will perform better at $189.95!

HX-1000 Printer/plotter	$179.95
HX-2000 Wafertape (digital tape drive)	$124.95
RS-232 Interface	89.95
HX-3000 RS-232 int. w/parallel IFC	109.95

Solid state software/wafertape software-call us!

FRANKLIN ACE 1200 with 128K RAM total dual processors-Two computers in one!
64K Apple compatible w/6502 processor
64K CP/M Z80-B processor inc. CP/M 2.2 and other features include: color, serial & parallel IFC'S, upper & lower case, etc.

Package One:
ACE 1200 dual processor, total 128K
Disk drive w/controller
Disk drive II only
40/80 column card
Dual IFC board, parallel/serial
Word Star software
Mail Merge software
AceCalc - spread sheet
Welcome diskette
Sugg. retail: $3500.00 Y/C:$1795.00

Package Two: Same as Package One with one Epson printer or Star Gemini 10X plus one 12" green monitor. Sugg. retail:$4100 Y/C:$2189.00

Same as Package One plus: 12" green monitor plus Letter Quality printer:

w/Diablo 620	2879.00
w/SCM TP 1	2479.00
w/Olivetti Praxis 41 5 language typewriter	2299.00
w/Brother 50	2259.00
w/C. Itoh F10	2999.00
w/Silver-Reed EX43	2299.00

and many more, please inquire
Opt'l interfaces & cables

SPECIAL OFFER TO ACCREDITED SCHOOLS–on Commodore Executive 64, SANYO MBC 550, & Franklin ACE 1000 & 1200–Buy 10 systems–GET 1 FREE! CALL for details & eligibility!

DON'T BUY A PORTABLE COMPUTER UNTIL YOU SEE & TRY THE NEW PORTABLE COMMODORE EXECUTIVE 64!
Briefcase style, 64K, detachable, 5-inch color monitor & built-in floppy disk drive. Compatible w/software designed for the popular Commodore 64.

6510 CPU(6502 program compatible)
Built-in 5" color monitor
(40 col x 25 lines in 16 colors)
Built-in 170K disk drive (second drive opt'l)
External video port (64 compatible)
Full upper/lower case detachable keyboard
Commodore Serial Bus
External system bus(C-64 compatible)
Only 5" x 14½", 27 lbs
IEEE-488 IFC
Music & sound capabilities

with SINGLE DISK DRIVE
Your cost:$995.00
with DUAL DISK DRIVES
Your cost:$1195.00

HURRY! FREE SOFTWARE PACKAGE with your purchase of the new Commodore EXECUTIVE 64 Portable Computer-ask for details when ordering!

It's about time! A NEW APPLE-COMPATIBLE 64K Computer with SWITCHABLE DUAL PROCESSOR-THE ROMAR II. It has 6502 & Z-80 processors; uses Apple software, CP/M based languages, Applesoft, Basic, Cobol, Forth, Fortran and Pascal. Optional plug-in boards will allow this computer to support Integer Basic, TRS-80, NEC-8001 and IBM CP/M-86. Approved by the U.S. Consumer Service to sell in the U.S.A. Includes 90-day warranty. It's about time the consumer got a price break!
72-key typewriter-style keyboard
Numeric pad
Built-in fan
80-watts switching power supply & more!

SPECIAL PACKAGES–

Package One:
One 64K Computer
One disk drive w/controller
One 12" green monitor
Your cost:$939.95

Package Two:
One 64K Computer
One disk drive w/controller
One second disk drive
Your cost:$1069.95

Package Three:
One 64K Computer
One disk drive w/controller
One Epson RX80 or Star Gemini 10X
Your cost:$1199.95

Due to the insane fluctuation of prices in the industry-call for current price-it may have changed by the time this ad appears.

Individual prices:

Romar II 64K computer	$595.00
Disk drive w/controller	299.95
Second disk drive	199.95
12" green monitor	99.95

HEWLETT PACKARD

HP-75C Computer $699.95

8K module		164.95
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Call for math pac, surveying pac, text formatter & VisiCalc for HP-75C

HP-10C	Scientific calc	59.95
HP-11C	Scientific calc	76.90
HP-12C	Financial calc	99.95
HP-15C	Scientific calc	99.95
HP-16C	Prog. sce scien. calc	99.95
HP-97	Prog. scien. w/print	595.00

HP-41C Prog. calculator	169.95
HP-41CV Prog. calculator	219.95
Optical wand	104.95
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Card reader for 41C/CV	159.95
HP 82163A Video interface	259.95
HP IL systems on hand	
IL interface module	104.95
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Extended memory module	64.95
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Memory module for 41C/CV	24.95
Quad memory module for 41C	65.00

COMPUTER PRINTERS

Brand	Model	Description	Your Cost
Diablo	620	Letter quality, 25 cps, hvy duty	999.95
Diablo	630	Letter quality, 40 cps	1799.95
Commodore	6400	(Diablo 630) 40 cps, heavy duty	1399.95
Juki	6100	Letter qual; 18 cps, has everything!	589.95
Qume	1140+	Letter quality, 40 cps, hvy duty	1369.95
NEC	7710	Letter quality, 55 cps, the best!	2095.00
NEC	3510	Letter quality, 35 cps, great unit!	1595.00
Olivetti	Praxis 41	Electronic T/W, 5 lang; inc. port	449.95
Epson	RX80	New printer, dot matrix	339.95
Epson	all models	All models inc. FX 80 - FX 100 & others	Call
Star	Gemini 10X	120 cps, dot matrix, Epson compatible	339.95
Star	Gemini 15	120 cps, 132 col; Epson compatible	489.95
Transtar	120P	Letter quality, 14 cps, has it all!	499.95
Toshiba	P1350	Corres. quality, 4 modes, 180 cps, inc. parallel IFC	1769.95
Transtar	T315	Color printer, 50 cps, 30 color shades	499.95
Okidata	92P (No. 1)	Corres. quality, 160 cps, dot matrix	569.95
Okidata	84P	200 cps-fast! dot matrix, corres. qual., 45 cps	1089.95
Okidata	83A	120 cps, serial & parallel, dot matrix	699.95
Okidata	2410P	350 cps-fast!, corres. quality, 85 cps-hvy duty	2499.95
NEC	PC 8023A	100 cps w6 100 cps w/tractor & more! Parallel IFC	499.95
NEC	PC 8025	120 cps, pin/friction, 136 col; 3K buffer, parallel IFC	799.95
Anadex	DP-9500A	150 cps, parallel or Serial; 2K buffer	1399.95
Anadex	DP-9625A	200 cps; 50 cps correspondance quality	1699.95

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Goods subject to availability; this ad supercedes all previous ads; FOB our warehouse; prices subject to change without notice; not responsible for typographical errors. all orders subject to verification; minimum shipping & handling:$5.95. Send for our catalog–$2 domestic, $5.95 foreign. Some of the goods not available all stores-Call first to be sure!

VISA

64; cassette, $39.95. Computech, POB 7000-309, Redondo Beach, CA 90277.

Neutral Zone, an arcade-type game. You are assigned to a perimeter gunnery pod to protect Alpha IV, a long-range early warning station that detects alien intruders. Engage the attack computer and take on a squadron of killer aliens. For the 64; floppy disk, $34.95. Access Software Inc., 925 East 900 S, Salt Lake City, UT 84105.

Scorpion, a survival game. As a scorpion, you must find food to store at home and defend yourself from dragons, stalkers, and pods that abound in the maze. For the VIC-20; cartridge, $39.95. Tronix (see address above.)

Type For Your Life, a graphic-action typing teacher for all levels. Typing speed can be set as high as needed and the text is widely varied. The graphics at the bottom of the screen keep eyes on the screen and add to the fun of learning. Alarms signal errors until they are corrected. For the VIC-20; cassette, $14.95. Apropos Technology (see address above).

Wordplay, a collection of five language-oriented programs. Jargon writes sounding phrases; Story writes personal short stories based on your input; Animal guesses which animal you're thinking of; Haiku writes Japanese poetry; and Secret is a cipher/decipher code program. For the VIC-20; cassette, $14.95. Apropos Technology (see address above).

IBM Personal Computer

C Compiler System, a utility program that accepts programs written in the C language and produces relocatable machine code in an Intel 8086 object-module format suitable for use by Microsoft LINK Linker. Floppy disk, $500. Microsoft Corp., 10700 Northup Way, Bellevue, WA 98004.

Electric Ledger, an easy-to-use checking program for personal or small business accounts that balances your checkbook, reconciles bank statements, and computes mortgage loan and compounded amount. Features include easy data entry, menu drive, search, and sort to any keyword. Floppy disk, $35. Datacon Consulting, 2311 West 5700 S, Roy, UT 84067.

Financial Planning for Supercalc, an electronic-spreadsheet enhancement program that lets you compute compound growth, annuities, discounted cash flows, profit planning, statistics, and real-estate finance. A quick reference guide is included. Floppy disk, $89.95. Howard W. Sams & Co., 4300 West 62nd St., Indianapolis, IN 46268.

Financial Planning for Visicalc, an electronic-spreadsheet enhancement program that lets you compute compound growth, annuities, discounted cash flows, profit planning, statistics, and real-estate finance. A quick reference guide is included. Floppy disk, $89.95. Howard W. Sams & Co. (see address above).

4Cast/1, a business-forecasting tool. This program is designed to save time and relieve you from the detailed statistical and mathematical aspects of forecasting using color graphics. Floppy disk, $725. Heurix Computer Products, POB 9227, Morristown, NJ 07960.

Metafile, an integrated software system combining many facilities necessary for the development of applications or for impromptu information reporting. Floppy disk, $1995. Sensor-based Systems, Olmsted Federal Building, Chatfield, MN 55923.

Novatron, a high-speed strategy game based on building walls to trap your opponent (the computer) or force it to crash into a wall before you do. Includes three levels of difficulty. Floppy disk, $34.95. Fast-N-Fun Video, 1074 East Sandpiper Dr., Tempe, AZ 85283.

Novatron Trilogy, a series of three games. Construction is a game based on building walls to trap your opponent; Mazerace is a two-player race in which you avoid obstacles and exit before time runs out; and in Grid Walker you try to shoot your opponents before being shot yourself. Floppy disk, $29.95. Fast-N-Fun Video (see address above).

The 1 Dir, an interactive directory-command system that eliminates the need to type DOS commands and filenames on the command line. It is also designed so that the new user can begin taking advantage of the PC's power right away, without requiring full knowledge of the DOS syntax. Floppy disk, $95. Bourbaki Inc., POB 2867, Boise, ID 83701.

Project Planner II, a project-planning program capable of scheduling large-scale engineering projects. It can also handle small business applications that require bar charts. Floppy disk, $110. Engineering Software, 120 Raven Crescent, Prince Rupert, British Columbia V8J 4C9, Canada.

Sandman Medical Office Management, a medical-accounting program for easy setup and maintenance of patients' records, charges, and payments. It offers reindexing of files and can print statements, insurance forms, and daily and monthly reports. Floppy disk, $1000. Perceptions Inc., 17 Pine Lake Dr., Arab, AL 35016.

Schultz's Treasure, an animated adventure in three-dimensional color. You must enter the Lost Dutchman's Gold Mine and retrieve the Mother Lode without being killed. Floppy disk, $34.95. Fast-N-Fun Video (see address above).

Tallymaster, an interactive financial-analysis program. Designed for personal and small business use, this program lets you easily summarize and analyze budgets and expenses. You can identify major categories of revenues, expenses, sales volumes, or manufacturing volumes or define up to 702 categories with names you select. Floppy disk, $129.95. Prosoft, POB 560, North Hollywood, CA 91603.

Tutor-PC/Graphics, a graphics-instruction program designed to aid the user in understanding BASIC graphics capabilities. Statements included are screen, color, line, draw, preset, circle, and paint. Requires color-graphics card. Floppy disk, $29.95. LDH Computing, POB 59-2982, Miami, FL 33159.

Ultralight Command, an arcade-type game. As Commander of a specially outfitted ultralight aircraft, you must defend unarmed supply boats. Your defenses include lasers and radar instruments. Floppy disk, $39.95. Fast-N-Fun Video (see address above).

Software Received

VIS/Bridge/REPORT, a package that enhances the printing capabilities of Visicalc. This program allows you to print variable column widths, align decimal points, justify numbers within a column, and automatically format reports to fit space requirements. Floppy disk, $79. Solutions Inc., POB 989, Montpelier, VT 05602.

TRS-80

Airstrike, a war-simulation game similar to those played by students in major military academies. You use combat task forces and weapons against various targets and target systems. To create realistic combat scenarios, tactical concepts such as air superiority, interdiction, close air support, and reconnaissance are included. For Models I and III; floppy disk, $29.95. Atron International, POB 8825, Fort Collins, CO 80525.

Bible Games—1, two educational games. Concentration tests your ability to match Biblical names or concepts. Biblical Fortunes tests your knowledge of names, events, phrases, and places in the Bible by presenting them one letter at a time. For Models I and III; cassette, $9.95. R & M Enterprises Software, 107 Peachtree St., POB 543, Elizabethtown, KY 42701.

Casino Black Jack, a graphics simulation of the card game blackjack. Up to seven players can ask for advice from the computer, shuffle and cut the deck, and see each player's and the house's accumulative profit or loss on screen. For the Model III; cassette, $19.50. Lillian G. Choi, 82 Nicholas Dr., Bristol, CT 06010.

The Drawing Board, a graphics-drawing program. Using commands from the keyboard, you can clear or invert the screen, print screen to printer, save and load picture to or from tape, disk, or memory. You can draw preprogrammed shapes, type text on the screen, draw lines from point to point, and fill in shapes. For Models I and III; cassette, $20. Larsen Co., 115 Bixby Dr., Milpitas, CA 95035.

Planets, an educational program that teaches astronomy by giving the location of planets, phases of the moon, and dates of meteor showers. The program can map out any location of the universe you choose. For the Color Computer; cassette, $6. Moses Engineering, POB 11038, Ardmore Highway Station, Huntsville, AL 35805.

User Communication Utility, a utility designed to allow a program to interact with a remote terminal, host computer, or other RS-232C-compatible devices such as a bar-code scanner. This gives users program control over messages transmitted and received. For the Model II; floppy disk, $85. Micro Design Computer Systems, 1325 South Falcon, Anaheim, CA 92804.

VIS/Bridge/GL, a utility package that lets you make projections with Visicalc based on General Ledger data without having to reenter data it already has. You can project financial data using Visicalc and compare your projections to actual results. For Models II, 12, and 16; floppy disk, $195. Solutions Inc., POB 989, Montpelier, VT 05602.

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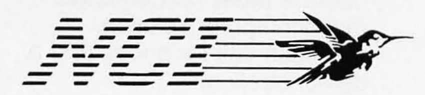
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Software Received

Texas Instruments

Bionic Bunny, an arcade-type game that is similar to Donkey Kong. Requires Extended BASIC. For the 99/4A; cassette, $15. Softwar III, 1307 Douglas Dr., Sterling, IL 61081.

Caterpillar, a fast-action nonviolent game. It runs in BASIC or Extended BASIC for faster action. For the 99/4A; cassette, $10.50. The Softies, Suite 229, 7300 Gallagher Dr., Edina, MN 55435.

Crillion Defender, an arcade-type game. You must protect Crill from the invading alien ships on a star map and in three-dimensional space-combat sequences. Requires Extended BASIC. For the 99/4A; cassette, $14.95. Greene-Bytes, POB 329, Waynesburg, PA 15370.

TI Res, a high-resolution plotting subroutine that lets you draw on a 196 by 256 pixel (picture element) screen. Requires Extended BASIC. For the 99/4A; cassette, $15. Softwar III (see address above).

ZX81/T/S 1000

Disassembler, a flexible utility package that lets you examine machine-code programs as mnemonics rather than just sequences of numbers. It can also display hexadecimal data and equivalent characters. Cassette, $14.95. Scientific Software, 6 West 61 Terrace, Kansas City, MO 64113.

Screen Machine, a utility package that provides a way of placing input prompts and response fields where you need them on the screen. This removes the limitations of the original input schemes. Cassette, $14.95. Syncmaster, POB 511, Oak Ridge, NC 27310.

Vu-Write, a word processor designed to provide an easy method of entering, changing, storing, and saving text. You can document programs and spreadsheets or write letters and newsletter columns. Cassette, $14.95. Syncmaster (see address above).

Other Computers

Number Cruncher, a financial-analysis and projection system that lets you create your own spreadsheet. Produce sophisticated reports that combine word-processing, spreadsheet, and information-management functions using simple English. For the DECmate; floppy disk, $400. Pyramid Data Ltd., POB 10116, Santa Ana, CA 92711.

White Water, seven adventure games. Shoot the rapids of the raging river for your best time or navigate the river to dock and collect treasures in the forest. For the Mattel Intellivision; cartridge, $39.95. Imagic, 981 University Ave., Los Gatos, CA 95030. ■

This is a list of software packages that have been received by BYTE Publications during the past month. The list is correct to the best of our knowledge, but it is not meant to be a full description of the product or the forms in which the product is available. In particular, some packages may be sold for several machines or in both cassette and floppy-disk format; the product listed here is the version received by BYTE Publications.

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NEC 8023A
C. ITOH PROWRITER
$7.99 EA. $86.29 DOZ.

CARTRIDGE RIBBONS FOR
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MX-80 $6.99 EA. $75.49 DOZ.
MX-100 $9.95 EA. $107.46 DOZ.

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8" $29.95 EA

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PAPER TIGER	6.95	75.06
MICROPRISM	7.99	86.29
PRISM	10.95	118.25

DISKETTE STORAGE BOXES
5¼" — BLUE OR BEIGE
$2.49 EA.

DUAL SPOOL RIBBONS FOR
OKIDATA PRINTERS

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80, 82, 83 92, 93	$2.75	$29.70
84	5.99	64.69

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Clubs and Newsletters

Israeli Computerists

The Israel Microcomputer Users Group (IMUG) in Tel Aviv comprises users, owners, and retailers of all brands of microcomputers who want to establish worldwide contact with other users groups and exchange newsletters. A newsletter, *The Microcomputer Age,* is produced each month and meetings are held regularly in Jerusalem. Membership is 350 shekels. For information, contact the Israel Microcomputer Users Group, POB 45030, Tel Aviv 61450, Israel.

Computers in Business

The Connecticut CP/M Users Group welcomes anyone interested in business and professional applications of microcomputers to attend nontechnical meetings held on the last Monday of the month at 7 p.m. in the McCook Auditorium of Trinity College in Hartford, Connecticut. For information, contact Malcolm Roth, 62 Burnwood Dr., Bloomfield, CT 06002, (203) 243-3063 evenings.

IBM PC Users Form Texas Club

The North Texas IBM Personal Computer Users Group is a nonprofit, independent group that focuses on the uses of computers in industry and the home. It meets on the third Saturday of each month at 9:30 a.m. in the Heroy Building on the Southern Methodist University campus in Dallas. A regular membership is $24, students are $12, and a professional membership is $36 a year. For details, contact John Pribyl, 2025 Rock Creek Dr., Arlington, TX 76010, (817) 275-4109.

California FIG

The FORTH Interest Group (FIG) is a worldwide organization that produces *FORTH Dimensions,* a bimonthly nonprofit publication that has a variety of articles on the applications of FORTH. New members are welcome. For information, contact the FORTH Interest Group, POB 1105, San Carlos, CA 94070, or call the FIG hot line at (415) 962-8653.

Chaos under Control

The Capitol Hill Atari Owners' Society (CHAOS) of Lansing, Michigan, produces a newsletter, *CONTROL,* that informs members about club activities. Both members and nonmembers can acquire disks from the club-maintained public-domain Atari software collection. Membership dues are $20 a year. For details, contact CHAOS, POB 16132, Lansing, MI 48901.

A-BUG in Boston

The Atari Boston Users Group (A-BUG), an affiliate of the Boston Computer Society (BCS), produces a monthly newsletter, *A-BUG,* that is free to members of the BCS or to those willing to exchange newsletters about the Atari. For details, contact the Boston Computer Society, Atari Boston Users Group, Three Center Plaza, Boston, MA 02108, (617) 367-8080.

For Programming

The *PPC Calculator Journal* is the monthly publication of PPC, a nonprofit public-benefit corporation in California dedicated to serving people in personal computing. The journal disseminates information related to the selection, evaluation, care, and applications of personal computers. Address inquiries to PPC, 2545 West Camden Place, Santa Ana, CA 92704, or call (714) 754-6226 evenings.

News for Veterinarians

A monthly newsletter for veterinarians, *Veterinary Computing,* covers computer applications in veterinary medicine. Subscriptions are $42 per year. Further information is available from American Veterinary Publications, PO Drawer KK, Santa Barbara, CA 93102.

SIGAIR in Toronto

A special interest group on artificial intelligence and robotics (SIGAIR) has been formed in Canada. Meetings are held on the first Friday of each month in the Toronto area. Anyone interested is welcome to attend. For information, write to SIGAIR, POB 874, Postal Station P, Toronto, Ontario M5S 2Z2, Canada.

Wisconsin Explorers

The Explorer-85 Users Group is for people who are interested in Netronics Explorer-85 equipment. A newsletter, *Explorations,* is produced. For more details, write to the Explorer-85 Users Group, 3430 93rd St., Sturtevant, WI 53177, or call Clarence Heier at (414) 886-1704.

Canadian COMIC

The Co-operators Microcomputer Club (COMIC) seeks communication with other IBM Personal Computer users groups. A newsletter may be produced. Contact the club through Adrian Groenendyk, The Co-operators, 1920 College Ave., Regina, Saskatchewan S4P 1C4, Canada.

Free to SAS Users

Users of SAS (Statistical Analysis Systems) mainframes can join SUGI (SAS Users Group International) and receive the free quarterly newsletter, *SUGI SIG/M.* A $2 annual donation is requested to cover printing and mailing costs. For a subscription or information, contact Jeff Bass, Bass Cybernetic Labs, RR 1, Box 124-B, Pittsboro, NC 27312.

A Graphics Update

The *S. Klein Newsletter on Computer Graphics* is produced twice a month by Technology & Business Communications Inc. It includes news that interprets significant developments in computer graphics including CAD/CAM, business graphics, and image processing. An annual subscription is $155 and includes a directory of hardware and software suppliers for computer graphics. The newsletter is also available to subscribers via Newsnet. For details, contact the *S. Klein Newsletter,* 730 Boston Post Rd., POB 89, Sudbury, MA 01776, (617) 443-4671.

News for Mental Health Workers

Each issue of *Computers in Psychiatry/Psychology* contains articles, reviews, a calendar of events, and a bibliography on hardware and soft-

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Clubs and Newsletters

ware for use in the mental-health profession. This clinical-resource newsletter covers applications of computers in such areas as neuropsychiatric and MMPI testing, EEG analysis, and office-management functions. Subscriptions are $40. Volumes from the previous five years are available. For information, write to *Computers in Psychiatry/Psychology*, 26 Trumbull St., New Haven, CT 06511.

For IBM PC Users In Winnipeg, Canada

The IBM PC Users Group of Winnipeg meets on the third Thursday of each month and produces a monthly newsletter that contains minutes of the preceding meetings and other information. A regular membership is $20; a junior membership is $12 for people under 18 years old; and a family membership is $25. Newsletter exchanges are welcome. For further details, contact the IBM PC Users Group of Winnipeg, c/o Business Development International, POB 5, Station A, Winnipeg, Manitoba R3K 1Z9, Canada, or call (204) 837-8509.

Atari Users In New Orleans

The New Orleans Atari Users Group (NOAUG) produces a newsletter that contains reviews, features, and random bits of information. Meetings are held every other Wednesday. For further information, contact NOAUG, 8223 Plum St., New Orleans, LA 70118, or call (504) 861-8772.

Sanyo Users Forum

The Sanyo Users Group (SUG/USA) provides information on the use of Sanyo computers, new products, and distribution of CP/M users-group disks in Sanyo formats. A quarterly newsletter is produced. A $10 annual membership includes access to a software library. For information, contact the Sanyo Users Group—U.S.A., 160 Emeline St., Providence, RI 02906.

Medical/Computer Clearinghouse

A newsletter for physicians devoted to such applications of computers as patient care and continuing education also updates key hardware, reviews, software, and contains the latest on medical networks. The *Physician Computer Monthly* is written in nontechnical language for the novice as well as the experienced user. Subscriptions are $95. For a free issue, send a request on letterhead to American Health Consultants, 67 Peachtree Park Dr., Atlanta, GA 30309.

Computer Federation

The Computer Users Federation (CUF) of Southeastern Wisconsin coordinates regional activities of mutual interest for users groups and clubs in personal computing. An area club directory and an annual computer fair are planned. The group produces a quarterly newsletter. For details, contact Computer Users Federation, POB 23483, Milwaukee, WI 53223. ■

If you would like BYTE readers to know about your club or newsletter send the details accompanied by no more than one newsletter to Clubs and Newsletters, BYTE Publications, POB 372, Hancock, NH 03449. Overseas groups are encouraged to participate. Please allow at least three months for your announcement to appear.

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Books Received

The ABCs of Microcomputers: A Computer Literacy Primer, Linda Gail Christie and Jess W. Curry Jr. Englewood Cliffs, NJ: Prentice-Hall, 1983; 228 pages, 15.3 by 22.8 cm, softcover, ISBN 0-13-000612-2, $7.95.

The Apple II Circuit Description, Winston D. Gayler. Indianapolis, IN: Howard W. Sams & Co., 1983; 174 pages, 23 by 28 cm, spiral-bound, ISBN 0-672-21959-X, $22.95.

Atari BASIC, Richard Haskell. Englewood Cliffs, NJ: Prentice-Hall, 1983; 192 pages, 21.5 by 27.8 cm, softcover, ISBN 0-13-049791-6, $13.95.

BASIC: An Introduction to Computer Programming with the Apple, Robert J. Bent and George C. Sethares. Monterey, CA: Brooks/Cole Publishing, 1983; 368 pages, 21.5 by 27.8 cm, softcover, ISBN 0-534-01370-8, $17.95.

BASIC Programming for the Classroom Teacher, Joan M. Miller, Ruth King Chaya, and Debra J. Santora. New York: Teacher's College Press (1234 Amsterdam Ave.), 1982; 288 pages, 24.8 by 17.5 cm, spiral-bound, ISBN 0-8077-2728-8, $15.95.

Bola Glossary of Electronic Data Processing and Computer Terms, English-Spanish & Spanish-English, vol. 1. Hesperia, CA: Bola Publications (8769 Devon Ave.), 1982; 218 pages, 21.5 by 28 cm, softcover, ISBN 0-943118-00-X, $29.95.

C Programming Guide, Jack Purdum. Indianapolis, IN: Que Corp., 1983; 272 pages, 23.5 by 18.8 cm, softcover, ISBN 0-88022-022-8, $17.95.

Communications Software for Microcomputers, Janet L. Bruman. San Jose, CA: CLASS, 1983; 25 pages, 21.5 by 27.8 cm, softcover, ISBN 0-938098-01-2, $12.50.

The Complete Book of Word Processing and Business Graphics, Walter Sikonowiz. Englewood Cliffs, NJ: Prentice-Hall, 1982; 216 pages, 15.3 by 22.8 cm, softcover, ISBN 0-13-158659-9, $14.95.

The Computer Cookbook, William Bates. Englewood Cliffs, NJ: Prentice-Hall, 1983; 384 pages, 21.5 by 27.8 cm, softcover, ISBN 0-13-165167-6, $12.95.

Computer Keyboarding, Touch-Type to High Data Entry Speed, Frank P. Donnelly. New York: Dictation Disc Co. (240 Madison Ave.), 1982; 33 pages, 21.5 by 28 cm, spiral-bound, ISBN none, $7.50.

Critical Issues in Software, Werner L. Frank. New York: John Wiley & Sons, 272 pages, 16.5 by 24 cm, hardcover, ISBN 0-471-87293-8, $25.

Document Preparation Systems, J. Nievergelt, G. Coray, J. D. Nicoud, and A. C. Shaw, eds. Amsterdam, The Netherlands and New York: North-Holland Publishing Co., 1982; 288 pages, 15.5 by 23 cm, hardcover, ISBN 0-444-86493-8, $46.50.

The Elementary Commodore 64, William B. Sanders. Chatsworth, CA: Datamost (8943 Fullbright Ave.), 1983; 224 pages, 12.5 by 20.5 cm, spiral-bound, ISBN 0-88190-001-X, $14.95.

The Fast Track to the Top Jobs in Computer Careers, Peter Muller. New York: Perigee Books, 1983; 128 pages, 13.8 by 20.5 cm, softcover, ISBN 0-399-50753-1, $4.95.

The Fast Track to the Top Jobs in Engineering Careers, Peter Muller. New York: Perigee Books, 1983; 128 pages, 13.8 by 20.5 cm, softcover, ISBN 0-399-50754-X, $4.95.

Fortran 77, A Top Down Approach, Nonna Kliss Lehmkuhl. New York: Macmillan Publishing Co., 1983; 480 pages, 17.5 by 25.5 cm, softcover, ISBN 0-02-369390-8, $18.95.

Fundamentals of Computer

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Avis Rapid Return service available for charge customers only who require no modification of rental agreement charges.

Aided Analysis and Design (CAA/CAD) of Integrated Circuits, Processes and Devices, Andres Fortino. Reston, VA: Reston Publishing Co., 1983; 144 pages, 21.3 by 28 cm, softcover, ISBN 0-8359-2120-4, $17.95.

A Guide to Programming—IBM Personal Computer, Bruce Presley. New York: Van Nostrand Reinhold, 1983; 304 pages, 21.5 by 27.8 cm, softcover, ISBN 0-442-26015-6, $16.95.

How to Write and Publish Engineering Papers and Reports, Herbert B. Michaelson. Philadelphia, PA: ISI Press, 1982; 172 pages, 15 by 22.8 cm, hardcover, ISBN 0-89495-016-9, $17.95.

The Illustrated Computer Dictionary, the editors of *Consumer Guide.* New York: Exeter Books and Skokie, IL: Publications International Ltd., 1983; 180 pages, 15.5. by 23 cm, softcover, ISBN 0-88176-099-4, $4.98.

Information U.S.A., Matthew Lesko. New York: Penguin Books, 1983; 1008 pages, 17 by 23.5 cm, softcover, ISBN 0-14-046-564-2, $19.95.

Mathematics for Data Processing, 2nd ed., Frank J. Clark. Reston, VA: Reston Publishing Co., 1974; 320 pages, 15.5 by 23.5 cm, hardcover, ISBN 0-87909-470-2, $21.95.

Microcomputers for Libraries: How Useful Are They?, Jane Beaumont and Donald Krueger, eds. Ottawa, Ontario, Canada: Canadian Library Association, 1983; 130 pages, 21.5 by 28 cm, spiral-bound, ISBN 0-88802-170-4, $12.

Le Microprocesseur 68000 et Sa Programmation, Patrick Jaulent. Paris, France: Eyrolles (61, Boulevard Saint-Germain), 1983; 168 pages, 15.5 by 24.3 cm, softcover, ISBN 8549, price not available.

More Subroutine Sandwich, John P. Grillo and J. D. Robertson. New York: John Wiley & Sons, 1983; 270 pages, 17 by 25 cm, softcover, ISBN 0-471-86921-X, $12.95.

Nine Steps to Effective EDP Loss Control, Tom S. Eason and Douglas A. Webb. Bedford, MA: Digital Press, 1983; 192 pages, 16 by 24.8 cm, hardcover, ISBN 0-932376-25-8, $21.

PC Clearinghouse Software Directory, 7th ed. Fairfax, VA: PC Clearinghouse Publishers (11781 Lee Jackson Highway), 1983; 840 pages, 27.5 by 21.3 cm, softcover, ISBN 0-88674-000-2, $29.95.

Problem Solving with Fortran 77, Larry Nyhoff and Stanford Leestma. New York: Macmillan Publishing Co., 1983; 368 pages, 17 by 25.5 cm, softcover, ISBN 0-02-388720-6, $18.95.

Programmer's Guide to CP/M, Sol Libes, ed. Morris Plains, NJ: Creative Computing Press (39 East Hanover Ave.), 1982; 204 pages, 20.5 by 27.5 cm, softcover, ISBN 0-916688-37-2, $12.95.

Radio Antennas, Stephen Gibson. Reston, VA: Reston Publishing Co., 1983; 176 pages, 15.3 by 22.8 cm, softcover, ISBN 0-8359-6358-6, $13.95.

6502 Assembly Language Programming, Judi N. Fernandez, Donna N. Tabler, and Ruth Ashley. New York: John Wiley & Sons, 1983; 288 pages, 17 by 25 cm, softcover, ISBN 0-471-86120-0, $12.95.

Subroutine Sandwich, John P. Grillo and J. D. Robertson. New York: John Wiley & Sons, 1983; 274 pages, 17 by 25 cm, softcover, ISBN 0-471-86920-1, $12.95.

Successful Business Computing, M. Tampoe. Woburn, MA: Butterworths, 1982; 130 pages, 14 by 22 cm, hardcover, ISBN 0-408-01217-X, $19.95.

SuperCalc: The Book, Donald H. Beil. Reston, VA: Reston Publishing Co., 1983; 304 pages, 18 by 24 cm, hardcover, ISBN 0-8359-7306-9, $21.95.

TRSDOS 2.3 Decoded & Other Mysteries, James Lee Farvour. Upland, CA: IJG Inc. (1953 West 11 St.), 1982; 304 pages, 20.8 by 17.5 cm, softcover, ISBN 0-936200-07-3, $29.95.

TRS-80 Extended Color BASIC, Richard Haskell. Englewood Cliffs, NJ: Prentice-Hall, 1983; 176 pages, 21.5 by 27.8 cm, softcover, ISBN 0-13-931246-3, $12.95.

UCSD Pascal: A Considerate Approach, David Price. Englewood Cliffs, NJ: Prentice-Hall, 1983; 208 pages, 17.3 by 23 cm, softcover, ISBN 0-13-935460-3, $12.95.

Unix Programmer's Manual, 7th ed., vol. 2, Bell Telephone Laboratories. New York: Holt, Rinehart and Winston, 1983; 624 pages, 21 by 27.8 cm, softcover, ISBN 0-03-061743-X, $34.95.

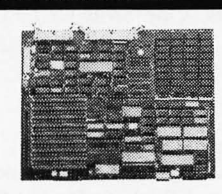
Up Front Financing: The Entrepreneur's Guide, A. David Silver. New York: John Wiley & Sons, 1982; 264 pages, 16 by 23.8 cm, hardcover, ISBN 0-471-86386-6, $15.95. ■

This is a list of books received at BYTE Publications during this past month. Although the list is not meant to be exhaustive, its purpose is to acquaint BYTE readers with recently published titles in computer science and related fields. We regret that we cannot review or comment on all the books we receive; instead, this list is meant to be a monthly acknowledgment of these books and the publishers who sent them.

The Micromint Collection

Micromint. Supporting the varied projects that appear in Steve Ciarcia's monthly article in BYTE magazine, "Ciarcia's Circuit Cellar." Offering a wide range of computers and peripherals supporting the needs of the hobbyist as well as worldwide corporate clients.

MPX-16 MICROCOMPUTER IBM PC COMPATIBLE



The MPX-16 is Steve Ciarcia's most ambitious project to date. The computer runs all application software written for the IBM PC and is IBM PC bus compatible. Can be used with video monitor & IBM keyboard with optional adapter.

Buy the MPX-16 in the form that best meets your budget. As a bare board, as a wave-soldered board that contains all components less the IC's, as an assembled and tested circuit board or as a complete system.

As featured on the cover of "BYTE" magazine. Also featured in "Ciarcia's Circuit Cellar" November, December 1982 & January 1983.

- Runs all application programs written for the IBM PC (simply boot up the system and slip in a disk formatted for the IBM PC).
- IBM PC bus compatible + 9 expansion slots.
- Intel 8088 16-bit microprocessor.
- Optional Intel 8087 math coprocessor.
- 256K bytes on-board memory.
- Up to one megabyte of system memory.
- Up to 64K bytes of system ROM/EPROM.
- Two RS-232C serial I/O ports.
- Three parallel I/O ports.
- Disk controller for 5¼" or 8" drives.
- Sixteen levels of vectored interrupts.

MPX-16 Microcomputer circuit board assembled w/64K RAM, CP/M-86 or MS-DOS ..... $1,895.
MPX-16 as above with 256K RAM .... 2,135.
MPX-16 Semi-Kit (wave soldered circuit board w/all components) less IC's .... 595.
Complete kit of IC's w/256K RAM .... 595.
MPX-16 Unpopulated (bare) pc board .... 300.
CP/M-86 Operating System .... 200.
MS-DOS optionally available
MPX-16 Switching Power Supply including cable harness for 2 disk drives .... 300.
MPX-16 Technical Reference Manual ....50.
MPX-16 Metal Enclosure with cutouts for two 5¼" full height drives .... 300.
Tandon TM 100-2 double density drive ...... 300.
Televideo Model 910 Serial Terminal .... 675.
IBM PC Keyboard Interface Adapter .... 100.
Serial terminal cable .... 35.
Parallel printer cable .... 35.

Shipping and handling additional on MPX-16 orders.

Z8 BASIC SYSTEM CONTROLLER NEW!!!

Replaces Z8 Basic Computer/Controller



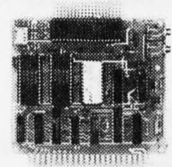
As featured in Ciarcia's Circuit Cellar, BYTE magazine, July & August 1981.

- Uses Zilog Z8671 single chip microcomputer.
- On board tiny BASIC interpreter.
- 2 parallel ports plus serial I/O port.
- Just connect a CRT terminal and write control programs in BASIC.
- 2K bytes of RAM, up to 4K bytes of ROM.
- Baud rates 110-9600 BPS.
- Data and address buses available for 124K memory and I/O expansion.
- Consumes only 1.5 watts at +5, +12 & −12.
- Cross Assemblers for various computers.

BCC11 Assembled & Tested .... $149.
New Low Price

IBM PC is a trademark of International Business Machines, Inc.
CP/M86 is a trademark of Digital Research Inc.
MS-DOS is a trademark of Microsoft Inc.
Z8 is a trademark of Zilog Inc.

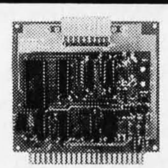
Z8 MEMORY, I/O EXPANSION, CASSETTE INTERFACE



- Add up to 8K of memory plus 3 parallel ports.
- Cassette Interface—300 baud K.C. Standard.

BCC03 w/4K Assembled & Tested .... $140.

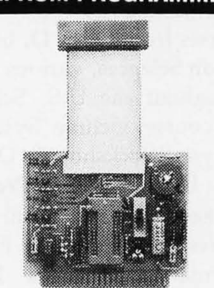
Z8 ANALOG TO DIGITAL CONVERTER NEW!!!



- Uses Analog Devices 7581 8 channel 8 bit IC.
- Adds Process Control capability to the Z8.
- 1000 samples per second.

BCC13 Assembled & Tested .... $140.

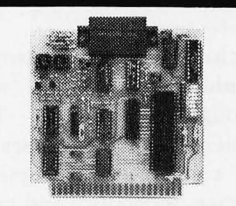
Z8 EPROM PROGRAMMER



- Transfer BASIC or Assembly Language application programs from RAM to 2716 or 2732 EPROM.
- Requires Z8 Expansion Board for operation.

BCC07 Assembled & Tested ....$145.

Z8 SERIAL EXPANSION BOARD



- Adds additional RS 232C and opto-isolated 20 ma current loop serial port to the Z8.
- Runs at 75 to 19,200 baud in all protocols.

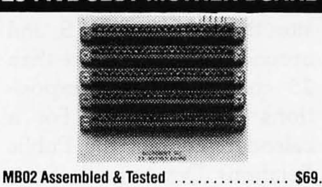
BCC08 Assembled & Tested .... $160.

Z8 16K MEMORY EXPANSION BOARD NEW!!!

- Add 16K of additional memory, RAM or EPROM, to your Z8 System Controller in any multiple.
- Uses 2016, 6116, 2716 or 2732 memory types.

BCC14 w/8K Assembled & Tested .... $120.

Z8 FIVE SLOT MOTHER BOARD



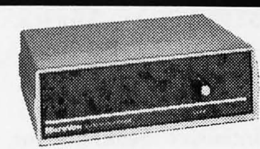
MB02 Assembled & Tested .... $69.

Z8 CROSS ASSEMBLERS

From Allen Ashley
TRS-80 Model I or III .... $75.
CP/M 2.2 8" or Northstar 5¼" .... 150.
From Micro Resources
CP/M 2.2 8" or APPLE 5¼" .... 75.

SPEECH SYNTHESIZERS

MICROVOX TEXT-TO-SPEECH SYNTHESIZER



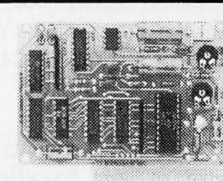
As featured in Ciarcia's Circuit Cellar BYTE Magazine September, October 1982.

Microvox is a second generation professional voice quality text-to-speech synthesizer that is easily interfaced to any computer, modem, RS-232C serial or parallel output device and provides speech of unbelievable clarity.

- Unlimited vocabulary.
- 64 programmable inflection levels.
- 6K text-to-speech algorithm.
- Full ASCII character set recognition and echo.
- RS232C and parallel output.
- 1000 character buffer, 3000 optional.
- Adjustable baud rates (75-9600).
- Spelling output mode.
- 7 octave music and sound effects.
- On board audio amplifier & power supply.
- X-On/X-Off handshaking.

MV01 Assembled with 1K buffer .... $299.
MV02 Complete Kit with 1K buffer .... 219.
Add $15.00 for 3K buffer option.

SWEET-TALKER VOICE SYNTHESIZER





As featured in Ciarcia's Circuit Cellar BYTE Magazine, September 1981

The Sweet-Talker Voice Synthesizer allows you to add speech of unlimited vocabulary to your Apple II or any computer with a parallel printer port at very low cost.

- Utilizes Votrax SC-01A speech synthesizer.
- Unlimited vocabulary.
- Text-to-Speech Algorithm on disk for Apple II.
- Contains 64 phonemes accessed by 6-bit code.
- Four levels of programmable inflection.
- On board audio amplifier & volume control.

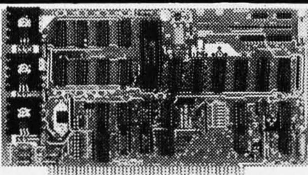
ST02 Apple II plug-in, Assembled & Tested with Text-to-Speech Algorithm on 3.3 disk .. 141.
NEW LOW PRICE!!!
ST01 Parallel Port Version, Assembled .... 99.
New Low Price

VOTRAX SC-01A PHONETIC SPEECH SYNTHESIZER

The SC-01A Speech Synthesizer is a completely self-contained solid state device that phonetically synthesizes continuous speech of unlimited vocabulary. Used in Microvox and Sweet-Talker.

SC01A Quantity 1-99 .... $44. ea.
100 + ... 32. ea.
1000 + ... 24. ea.

E-Z COLOR GRAPHICS INTERFACE



As featured in Ciarcia's Circuit Cellar BYTE Magazine, August 1982

Add color graphics, animation & 3-D effects to your S-100, TRS-80 Model I and III & Apple II at low cost. The Super Editor software package includes a pattern editor, sprite editor, slide show, and demo scenes all in BASIC. Can be used with Color Monitor or TV set and rf modulator.

- Resolution—256 X 192 Pixels.
- 16 colors including Black & Transparent.
- 16K Bytes on board I/O mapped video memory.
- Advanced TI TMS9918A Color Video Processor.
- 32 SPRITES facilitates 3-D effect.
- Composite Video output.
- Krell & Terrapin have LOGO software packages to support the E-Z Color Boards.

Apple II E-Z Color plug-in board with Super Editor on 3.3 disk.
EZ01 Assembled & Tested .... $150.
EZ02 Complete Kit .... 125.

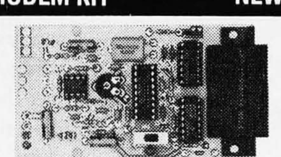
NEW!! S-100 E-Z Color Graphics board with sound generator, Atari type joy stick interface, plus MBasic CP/M Super Editor Software on 8" disk.

EZ04 Assembled & Tested .... $289.

TRS-80 Model I or Model III E-Z Color w/ Super Editor software, power supply and enclosure.

Assembled & Tested .... $249.
Complete Kit .... 219.

300 BAUD ANSWER/ ORIGINATE MODEM KIT NEW!!!



As featured in Ciarcia's Circuit Cellar BYTE Magazine, March 1983

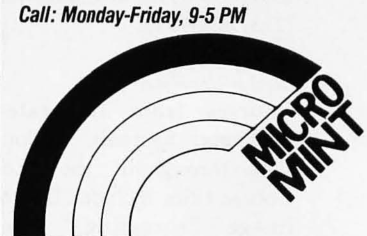
The newest item to Micromint's growing list of products is this 300 Baud Modem. It is crystal controlled, uses the TI TMS 99532 IC, contains just 25 parts and can be used with an acoustic coupler or in a direct connect mode.

MD04 Complete Kit .... $60.
MD05 Transformer for Direct Connect Mode .... 9.
AC01 Acoustic Coupler Kit .... 18.

TRIPLE VOLTAGE POWER SUPPLIES

+5v @ 300 ma. +/− 12v @ 25 ma.
UPS01 Assembled & Tested .... $35.
UPS02 Complete Kit .... 27.
+5v @ 1 Amp. + 12v @ .5 Amp. − 12v @ 50 ma.
UPS03 Assembled & Tested .... 60.
UPS04 Complete Kit .... 50.

MICROMINT INC. *561 Willow Avenue, Cedarhurst, NY 11516*
To Order: *Call Toll Free 1-800-645-3479*
For Information Call: *1-516-374-6793*
Call: Monday-Friday, 9-5 PM



Circle 297 on inquiry card.

Event Queue

October 1983

October
Courses in Continuing Engineering Education, Orlando, FL, San Diego, CA, and Washington, DC. Two of the available courses are "An Applications-oriented Approach to Artificial Intelligence" and "Computer Graphics Systems: Hardware, Software, and Applications." For information on dates, locations, and fees, contact Douglas Green, George Washington University, Continuing Engineering Education, Washington, DC 20052, (800) 424-9773; in the District of Columbia, (202) 676-8512.

October-November
Computer Showcase Expos, various sites throughout the U.S. This popular show will bring together hardware and software manufacturers, dealers, and consumers of small computer systems. For further details, contact the Interface Group, 160 Speen St., POB 927, Framingham, MA 01701, (800) 225-4620; in Massachusetts, (617) 879-4502.

October-November
Courses from the Continuing Education Institute, various sites throughout the U.S. Among the courses offered are "Database Machines," "Local Networks Technology and Applications," and "Man-Machine Interface." For more information, contact the Continuing Education Institute, Oliver's Carriage House, 5410 Leaf Treader Way, Columbia, MD 21044, (301) 596-0111; in California, (213) 824-9545.

October-November
Courses from Integrated Computer Systems, various sites throughout the U.S. Course titles include "Digital Image Processing," "Designing Real-Time Hardware for Digital Signal Processing," "Designing Digital Control Systems," and "Digital Signal Processing." The fee for these courses is $895. For information, contact Ruth Dordick, Integrated Computer Systems, 3304 Pico Blvd., POB 5339, Santa Monica, CA 90405, (213) 450-2060.

October-December
Intensive Seminars for Professionals, various sites throughout the U.S. *Electronics* magazine, a McGraw-Hill publication, offers seminars in management and such technical areas as speech recognition and synthesis, controlling electromagnetic interference, fundamentals of computer graphics, and microprocessor interfacing. Inhouse presentations can be arranged. For a catalog outlining seminars, locations, and fees, contact Irene Parker, McGraw-Hill Seminar Center, Suite 603, 331 Madison Ave., New York, NY 10017, (212) 687-0243.

October-December
James Martin Seminars and **Seminars of Excellence**, various sites throughout the U.S. and Canada. For a brochure describing these data-processing and computer-related seminars, contact Technology Transfer Institute, 741 10th St., Santa Monica, CA 90402, (213) 394-8305.

October-December
Seminars for Professional Development, various sites throughout the U.S. Datapro Research Corporation offers more than 35 professional development seminars in such areas as personal computers, data communications, systems and software, and office automation. Complete outlines and schedules are available from Datapro Research Corp., 1805 Underwood Blvd., Delran, NJ 08075, (800) 257-9406; in New Jersey, (609) 764-0100.

October-December
Software Workshops in MMSFORTH, Boston metropolitan area. These workshops are public versions of the professional training Miller Microcomputer Services (MMS) offers to client companies in support of the MMSFORTH product line. A variety of topics and skill levels are covered. Full details are available from Miller Microcomputer Services, 61 Lake Shore Rd., Natick, MA 01760, (617) 653-6136.

October-January 1984
Courses from Q. E. D. Information Sciences, various sites throughout the U.S. Scheduled courses include "Systems Analysis Workshop," "Database Design," and "Project Management and Control." Address inquiries to Q. E. D. Information Sciences Inc., Q. E. D. Plaza, POB 181, Wellesley, MA 02181, (800) 343-4848; in Massachusetts, (617) 237-5656.

October-January 1984
Technology Opportunity Conference, various sites throughout the U.S. This conference series focuses on the convergence of optical-storage, videodisc, and computer technologies. For full details, contact Technology Opportunity Conference, POB 14817, San Francisco, CA 94114, (415) 626-1133.

October-August 1984
Conferences and Expositions from the Society of Manufacturing Engineers, various sites throughout the U.S. and around the world. More than 25 conferences and expositions are scheduled. For a calendar, contact the Public Relations Department, Society of Manufacturing Engineers, One SME Dr., POB 930, Dearborn, MI 48121, (313) 271-0777.

October 10-12
CEPA 1983 Fall Conference, the Saint Paul, St.Paul, MN. Topics to be addressed at this conference sponsored by the Society for Computer Applications in Engineering, Planning, and Architecture (CEPA) include selection of software and hardware, experiences with applications, and networking of systems. An exhibit area will show various hardware and software products being used by design professionals. Contact Patricia Johnson, CEPA Inc., 358 Hungerford Dr., Rockville, MD 20850, (301) 762-6070.

October 10-12
Online '83, Palmer House, Chicago, IL. The fifth annual Online conference and exposition features introductory and advanced technical sessions, panel discussions, workshops, seminars, and addresses. The role of microcomputers and software for database searching, storage, creation, and communications will be emphasized. Registration information is available from Online Inc., 11 Tannery Lane, Weston, CT 06883, (203) 227-8466.

October 10-13
Information Management Exposition and Conference: Info 83, New York City Coliseum. Hardware and software exhibits and conference sessions will revolve around the theme "Tying the Information System to the Business Plan." A number of the conference sessions will deal with decision support systems. For details, contact the Marketing Manager, Info 83, 708 Third Ave., New York, NY 10017, (212) 661-8410.

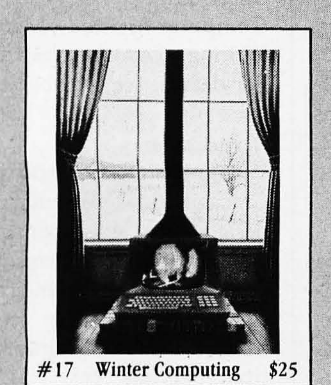
Collector Edition

BYTE COVERS

The Byte covers shown below are available as beautiful Collector Edition Prints. Each full color print is 11 in. x 14 in., including a 1 1/2 in. border, and is part of an edition strictly limited to 500 prints. Each print is faithfully reproduced from the original painting on museum quality acid-free paper, and is personally inspected, signed and numbered by the artist, Robert Tinney. A Certificate of Authenticity accompanies each print attesting to its quality and limited number.

Collector Edition Prints are carefully packaged flat to avoid bending, and are shipped first class. The price of each print is $25, plus $3 per shipment for postage and handling ($8 overseas). The prints are also available as 4-print sets: Set 9-12, Set 13-16, and Set 17-20. Each set costs $80, plus postage and handling.

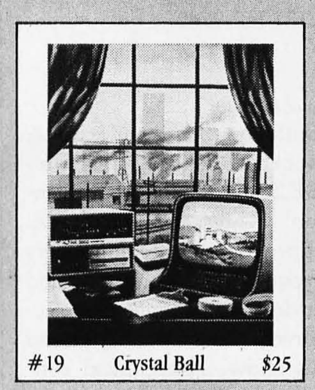
To order your own favorite Byte cover as a beautiful Collector Edition Print, use the convenient coupon below. Visa or MasterCard orders may call 1-504-272-7266.



#17 Winter Computing $25



#18 Seventeen Seventy-Six $25



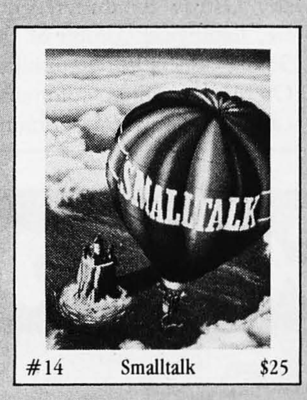
#19 Crystal Ball $25



#20 Digital Arts $25



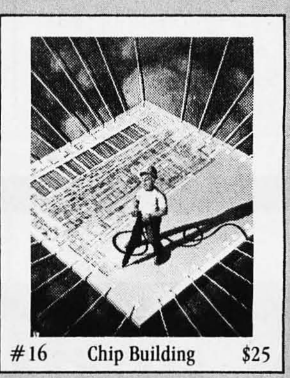
#13 Future Computers? $25



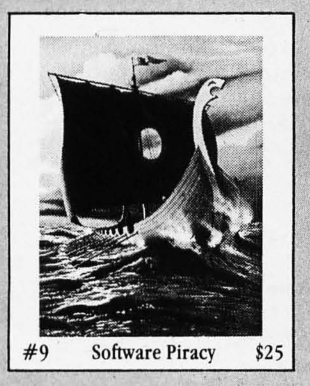
#14 Smalltalk $25



#15 Software $25



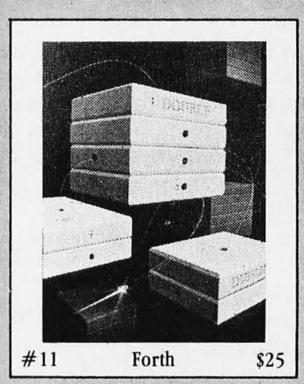
#16 Chip Building $25



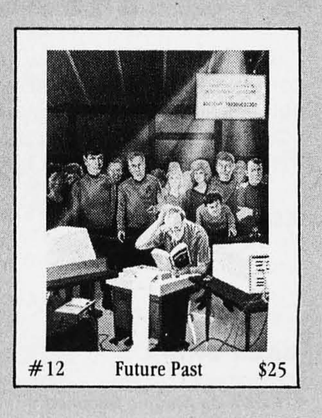
#9 Software Piracy $25



#10 Programming Route $25



#11 Forth $25



#12 Future Past $25

Please send me the following Prints ($25), or Sets ($80).

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	postage & handling $3.00 (Overseas $8.00)	$______
	TOTAL	$______

☐ I have enclosed check or money order.

☐ Visa ☐ MasterCard

Card No.________________

Exp. Date:________________

SHIP MY PRINTS TO:

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1864 N. Pamela Drive
Baton Rouge, LA
70815

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CALL 1-504-272-7266
Daytime or Evenings

Circle 473 on inquiry card.

October 10-14
Defense Computers–Graphics–DCG '83, Convention Center, Washington, DC. Sessions and tutorials will complement this conference and exhibition about computers and graphics for the defense community. For more information, contact DCG '83, Suite 333, 2033 M St. NW, Washington, DC 20036, (202) 775-9556.

October 11
Computer-assisted Manual Writing, Seattle, WA. This one-day seminar is designed to teach attendees how to produce good software manuals. The sponsor will demonstrate a software package for automated documentation development called Manual Maker. The fee is $195. For further information, contact Promptdoc, 833 West Colorado Ave., Colorado Springs, CO 80905, (303) 471-9875.

October 11-12
Computer-aided Design Conference—CADCON East '83, Boston, MA. This conference consists of technical programs and exhibitions organized exclusively for computer-aided-design engineering. Details are available from Morgan-Grampian Expositions Group, 2 Park Ave., New York, NY 10016, (212) 340-9780.

October 11-13
Southwest Semiconductor & Electronics Exposition–SSE '83, Civic Plaza Convention Center, Phoenix, AZ. Approximately 200 suppliers of equipment, materials, and services used in the electronics industry will attend this show. A technical conference will be held. Contact Leigh Crystall, Cartlidge & Associates Inc., Suite 205, 4030 Moorpark Ave., San Jose, CA 95117, (408) 554-6644.

October 11-14
Understanding Microprocessor-based Equipment and Troubleshooting, Rodeway Inn at Disneyland, Orange, CA. This course is designed to provide technicians and engineers with a background in microprocessor fundamentals and troubleshooting techniques. Equipment familiarization and hands-on experimentation are emphasized. The registration fee is $595; multiple discounts are offered. Contact Micro Systems Institute, Garnett, KS 66032, (913) 898-6152.

October 12-21
The Sixth International Trade Exhibition on Office Organizational Systems, Office Furniture, and Office Aids—Systemotechnika '83, Vassilievsky Ostrov Exhibition Centre, Leningrad, Union of the Soviet Socialist Republics. On display will be communications systems, microfilming equipment and systems, data-processing equipment, and computers. For details, contact Düsseldorfer Messegesellschaft mbH-NOWEA—Central Division—Foreign Fairs, Düsseldorf Exhibition Centre, 4000 Düsseldorf 30, Federal Republic of Germany; tel: (02 11) 45 60-1.

October 13
Computer-assisted Manual Writing, Los Angeles, CA. For details, see October 11.

October 13-14
Computers in Construction, Chicago, IL. This seminar is designed to assist construction management firms and contractors in acquiring computer systems. The fee is $425. Contact CIP Information Services Inc., 1105-F Spring St., Silver Spring, MD 20910, (301) 589-7933.

October 13-15
Edutech/East '83, Civic Cen-

ter, Philadelphia, PA. This conference and exposition is designed for educators at all levels. Presentations will address such topics as computer-aided instruction, administrative uses of computers, classroom management, programming, research applications, authoring languages, and literacy. The format includes workshops, seminars, demonstrations, hands-on sessions, discussions, and micro courses. Hardware, software, and publishing companies will exhibit their wares. Contact Carol Houts, Judco Computer Expos Inc., Suite 201, 2629 North Scottsdale Rd., Scottsdale, AZ 85257, (800) 528-2355; in Arizona, (602) 990-1715.

October 14-15
Computers and Reading/ Learning Difficulties, Dallas, TX. Workshops, hands-on exhibits, and speakers will explore such topics as using computers in learning disability classrooms and evaluating software. This program is designed for all education levels. For information, contact Frost Conference Management, Department I, 1070 Crows Nest Way, Richmond, CA 94803, (415) 222-1249.

October 14-15
The Fifth Annual FORTH Convention, Hyatt Hotel, Palo Alto, CA. Hands-on tutorials, exhibits, lectures, and discussions highlight this event. The theme is "FORTH-based Systems – A Look Into the Future." Registration is $5. Full details are available from the FORTH Interest Group (FIG), POB 1105, San Carlos, CA 94070, (415) 962-8653 (FIG hot line).

October 14-16
Futureteach Conference, Cathedral Hill Hotel, San Francisco, CA. General sessions, hands-on exhibits, and specialized workshops will seek to impart an understanding of how technology has and will continue to alter the way in which classroom instructors teach. For information, contact Westly Enterprises, 3697 South Court, Palo Alto, CA 94306, (415) 494-7115.

October 14-16
The UCSD Pascal System Users Society (USUS) Fall Meeting, Crystal City Hyatt Hotel, Arlington, VA. This meeting will feature presentations, hardware and software demonstrations, language tutorials, and special-interest group meetings. Contact Thomas Woteki, Information Systems Inc., Suite 202, 3865 Wilson Blvd., Arlington, VA 22203, (703) 522-8898.

October 15-16
Amacom, City Park campus, Delgado Community College, New Orleans, LA. This hamfest/computerfest offers demonstrations, sessions, commercial exhibits, and a flea market. Contact Amacom '83, POB 73665, Metairie, LA 70033, or call Bill Bushnell, WA5MJM, at (504) 887-5022.

October 15-16
The Seventh New Jersey Microcomputer Show and Flea Market, Meadowlands Hilton Hotel, Secaucus, NJ. Featured will be home, hobby, and small business computers, software, supplies, books, and accessories. Admission is $5 for adults; $2 for children. Contact Kengore Corp., POB 13, Franklin Park, NJ 08823, (201) 297-2526.

October 16-18
The Fifth Annual Hong Kong Consumer Electronics Show, New World Hotel and Regent Hotel, Hong Kong. For details, contact IBS Trade Fair

(Please turn the page)



Ltd., 17th Floor, Tung Sun Commercial Centre, 200 Lockhart Rd., Hong Kong; tel: 5-732388-9; Telex: 63037 HKIBS HX.

October 16-18
Texas Association for Educational Data Systems 1983 Convention, Austin Hilton Hotel, Austin, TX. The theme for this year's convention is "Computer Literacy." The keynote speaker will be Captain Grace Hopper of the U.S. Navy. Information may be obtained from Tom Hopper, Northside ISD, 5900 Evers Rd., San Antonio, TX 78238, (512) 618-8330, ext. 212.

October 17-19
The Eighth Conference on Local Computer Networks, Minneapolis, MN. The theme for this conference is "Practical Applications and Issues in Local Computer Networks." Papers and tutorials will address such issues as users' versus manufacturers' needs, public versus private networks, software, and VLSI (very-large-scale integration). Contact the IEEE Computer Society, POB 639, Silver Spring, MD 20901.

October 17-21
Systems 83, Munich, West Germany. Computers, peripherals, and software will be displayed by more than 600 firms from 35 nations. For additional information, contact Kallman Associates, 5 Maple Court, Ridgewood, NJ 07450, (201) 652-7070.

October 18-20
The Fourteenth Annual International Test Conference, Franklin Plaza Hotel, Philadelphia, PA. For information, contact the Conference Registrar, POB 371, Cedar Knolls, NJ 07927, (201) 267-7120.

October 18-21
HP 1000 IUG 1983 International Conference, Hyatt Regency Hotel, Fort Worth, TX. This conference features technical sessions and tutorials for users of the Hewlett-Packard 1000 family of real-time engineering and scientific computers. Contact the Conference Manager, HP 1000 IUG, 289 South San Antonio Rd., Los Altos, CA 94022, (415) 941-1943.

October 18-21
The Third Symposium on Microcomputer and Microprocessor Applications-μP '83, Hotel Duna Intercontinental and the Hungarian Academy of Sciences, Budapest, Hungary. The conference language will be English. Full details are available from Mrs. I. Bába, Scientific Society for Telecommunication, POB 451, H-1372 Budapest, Hungary; tel: (36) 1 113-027; Telex: MTESZ 22-5792.

October 18-21
Understanding Microprocessor-based Equipment and Troubleshooting, Belmont-Marine World Holiday Inn, Belmont, CA. For details, see October 11-14.

October 19-20
Calgary Computer & Office Automation Show and Conference, Roundup Centre, Calgary, Alberta, Canada. For details, contact Industrial Trade Shows of Canada, 20 Butterick Rd., Toronto, Ontario M8W 3Z8, Canada, (416) 252-7791.

October 19-21
The Fourth Canadian Symposium on Instructional Technology, Westin Hotel, Winnipeg, Manitoba, Canada. This symposium, designed for professionals in education and training and those interested in computer-aided learning, will explore the theme "Computer Tech-

nologies for Productive Learning." Topics on the agenda include computer awareness and literacy in schools and society, systems technology, and computer-aided training and retraining for business, industry, and government. A products exhibition will be held. Contact Ken Charbonneau, Conference Services Office, National Research Council of Canada, Ottawa, Ontario K1A 0R6, Canada, (613) 993-9009; Telex: 053-3145.

October 19-21

IDATE–The Fifth International Conference, Montpellier, France. The theme for this conference, sponsored by the International Telecommunication Union, is "Picture Networks." Topics of interest include network functioning and areas of applications, economics and law relating to the visual media, network languages, and languages on the networks. The conference language is French. For further details, contact Francois Rabaté, Responsable Scientifique, Journées Internationales 1983, IDATE–Bureaux du Polygone, 34000 Montpellier, France; tel: (33–67) 65 48 48; Telex: IDATE 490 290.

October 19-21

The National Software Show, Trade Show Center, San Francisco, CA. Full details are available from Raging Bear Productions Inc., Suite 175, 21 Tamal Vista Dr., Corte Madera, CA 94925, (800) 732-2300; in California, (415) 924-1194.

October 19-21

SIBEC–Info Expo, Palais des Congres, Montreal, Québec, Canada. Exhibits related to the computer and office automation industries will be held. An international lineup of speakers has been invited. Contact Informatique Québec (Info Expo) Ltée, 1057 Avenue Laurier Ouest, Outremont, Québec H2V 2L2, Canada, (514) 270-5481; in the Toronto area, call (416) 281-3459.

October 19-22

Management Executives Conference, The Breakers, Palm Beach, FL. The "Third Industrial Revolution" is the theme for this conference sponsored by the American Society of Mechanical Engineers (ASME). Management experts will speak on such topics as executive effectiveness and management for international competition. Complete conference details are available from Wendy Morris, ASME, 345 East 47th St., New York, NY 10017, (212) 705-7788.

October 19-22

Percompasia 83–The Second South East Asian Personal Computer Hardware & Software Show & Conference, World Trade Centre, Singapore, Republic of Singapore. This show is devoted to all aspects of personal computing. Further details are available from Overseas Exhibition Services Ltd., 11 Manchester Square, London W1M 5AB, England; tel: 01 486 1951; Telex: 24591.

October 23-26

The Seventh Annual Symposium on Computer Applications in Medical Care (SCAMC), Baltimore Convention Center, Baltimore, MD. Some of the topics to be covered include medical applications and solutions to problems of computers and technology in health care. For details, contact SCAMC, George Washington University Medical Center, Office of Continuing Medical Education, 2300 K St. NW, Washington, DC 20037, (202) 676-8928.

October 24-25

The Second Annual Pacific Northwest Computer Graphics Conference, Eugene Con-

ference Center, Eugene, OR. The theme for this multidisciplinary conference is "Applications on the Leading Edge." The goal is to present state-of-the-art computer graphics applications in architecture, medicine, landscaping, fine arts and graphic design, film and video, the sciences, and engineering. Exhibits of noncommercial graphics works and commercial product displays will complement the conference sessions. Information is available from the Second Annual Pacific Northwest Computer Graphics Conference, 111 Susan Campbell Hall, University of Oregon, Eugene, OR 97403, (503) 686-5555.

October 24-26
The Annual Conference of the Association for Computing Machinery–ACM '83, Sheraton Centre Hotel, New York, NY. Exhibits of computer hardware and software and paper sessions will focus on the conference theme, "Extending the Human Resource." The emphasis will be on theory and practices of personal computing. Highlighting the conference will be the Fourth International Computer Chess Championships. For details, contact Thomas A. D'Auria, Assistant Commissioner, City of New York, Computer Service Center, 11th Floor, 111 8th Ave., New York, NY 10011, (212) 620-5055.

October 25-27
Andean Informatics '83, Bogota, Colombia, South America. This is the first major international exhibition and conference to be held in the Andean region. For details, contact Informatics '83, Suite 219, 3421 M St. NW, Washington, DC 20007, (703) 920-9595.

October 25-28
Working Conference on Prototyping, Brussels, Belgium. This conference will focus on the user-oriented development of information systems supported by prototyping. Research and technical papers will be presented. The sponsor is the Commission of the European Communities. For information, contact Reinhard Budde or Heinz Zuellighoven, GMD-IST Postfach 1240, Schloss Birlinghoven, D-5205, St. Augustin 1, West Germany; tel: 02241/14-2440; Telex: 8 89 469 gmd d.

October 26-28
Developing Long-Range Systems Strategies, Sheraton Hotel, Washington, DC. This is part of the George Washington University Executive Systems Forum series. Contact the Conference Manager, U.S. Professional Development Institute, 1805 Powder Mill Dr., Silver Spring, MD 20903, (301) 445-4400.

October 27-28
Computers in Construction, Washington, DC. For details, see October 13-14.

October 28-30
Applefest, Moscone Center, San Francisco, CA. More than 300 displays and booths of Apple computer equipment and accessories will be featured. Seminars, panel discussions, conferences, and workshops will be held. Details are available from Northeast Expositions Inc., 822 Boylston St., Chestnut Hill, MA 02167, (800) 343-2222; in Massachusetts, (617) 739-2000.

October 30-November 2
DPMA Baltimore '83, Convention Center and Hyatt Regency Hotel, Baltimore, MD. The theme for this conference, sponsored by the Data Processing Management Association (DPMA), is "Information on the Firing Line." Seminars, workshops, general sessions, and product displays will be featured. For details, contact Jim Osowski, DPMA International Head-

quarters, 505 Busse Highway, Park Ridge, IL 60068, (312) 825-8124.

October 30-November 4
Engineering Foundation Conference, Niagara-on-the-Lake, Ontario, Canada. The theme of this conference is "Emerging Computer Techniques in Stormwater and Flood Management." Topics to be covered include hardware and software applications in hydrometeorological data acquisition and data storage, retrieval and presentation. For details, contact Dr. William James, Civil Engineering Department, McMaster University, Hamilton, Ontario L8S 4L7, Canada, (416) 527-6944.

October 31-November 2
The Ninth International Conference on Very Large Databases, Palazzo dei Congressi, Florence, Italy. This conference seeks to identify and encourage the research, development, and applications of database technology. Subjects of interest include database control, modeling and managing unformatted data, and novel environments and applications of database technology. In the U.S., contact Mario Schkolnick, K55-281, IBM Research Labs, 5600 Cottle Rd., San Jose, CA 95193, (408) 256-1648. In Italy, contact Renzo Pinzani, Istituto di Matematica U. Dini, Viale Morgagni, 67/A, 50134 Florence, Italy.

October 31-November 3
International Conference on Computer Design-VLSI in Computers, Rye Town Hilton, Port Chester, NY. This conference will cover the VLSI (very-large-scale integration) aspects of the interaction between fabricators and systems designers in hardware, software, and reliability in computers. Contact the IEEE Computer Society, POB 639, Silver Spring, MD 20901.

October 31-November 4
Structured Systems Design/Structured Program Design, Kansas City, MO. For details, contact Ken Orr and Associates Inc., 1725 Gage Blvd., Topeka, KS 66604, (800) 255-2459; in Kansas, (913) 273-0653.

October 31-November 4
Welcome to the World of Personal Computing, Washington, DC. This is a comprehensive introduction on how to use microcomputer technology in business, industry, and government. The workshop agenda offers six modules ranging from user productivity to software reliability. For details, contact Keston Associates, 11317 Old Club Rd., Rockville, MD 20852, (301) 881-7666.

November 1983

November 1-2
The Annual Fall Conference of the Iowa Association for Educational Data Systems, Des Moines, IA. "Quality Software for the 80s: Development, Selection, and Usage" will be the focus of more than 40 sessions presented during this conference. Three preconference workshops will be held on October 31. For details, contact Phillip J. Berrie, Educational Services Division, Heartland AEA 11, 1932 Southwest Third St., Ankeny, IA 50021.

November 1-3
INTECH '83—The Integrated Office Technology Conference and Exposition, McCormick Place, Chicago, IL. This conference and exposition is designed to provide top management with high-level seminars, workshops, and equipment demonstrations that address the integration of information technologies and applications. Contact Mary

Event Queue

Beth Gouled, National Trade Productions Inc., 9418 Annapolis Rd., Lanham, MD 20706, (800) 638-8510; in Maryland, (301) 459-8383.

November 1-3

The 1983 Federal Office Automation Conference, Convention Center, Washington, DC. The theme for this conference and exposition is "Making It Work." The conference program will consist of seminars, workshops, technology briefings, and major addresses. The exposition segment will provide displays of the latest office automation equipment, systems, and services. Further details are available from the National Council for Education on Information Strategies, POB N, Wayland, MA 01778, (800) 343-6944; in Massachusetts, call (617) 358-5356, collect.

November 1-3

Western Design Engineering Show and Conference, Convention Center, Los Angeles, CA. Short courses on the agenda include "Principles of Robotics for Engineers," "Effective Project Management," and "Programming Personal Computers." Many of the 12 short courses will provide hands-on experience. An exhibition area will be featured. Contact the Marketing Director, Western Design Engineering Show, 708 Third Ave., New York, NY 10017, (212) 661-8410.

November 2-4

Digital Control Seminar, Washington, DC. For details, contact Hellman Associates Inc., Suite 300, 299 California Ave., Palo Alto, CA 94306, (415) 328-4091.

November 2-4

Edmonton Computer and Office Automation Show, Convention Centre, Edmonton, Alberta, Canada. For full details, contact Industrial Trade Shows of Canada, 20 Butterick Rd., Toronto, Ontario M8W 3Z8, Canada, (416) 252-7791.

November 2-4

The First Annual Computer Vertical Market Conference, Meadowlands Hilton, East Rutherford, NJ. This conference, sponsored by Frost and Sullivan, will explore the impact of the new integrated software approaches and the importance of maintenance and support functions. Speakers will address vertical marketing issues from the perspective of the user, vendor, and industry analyst. Full particulars are available from Carol Sapchin, Frost and Sullivan Inc., 106 Fulton St., New York, NY 10038, (212) 233-1080.

November 3-4

Computers in Construction, Scottsdale, AZ. For details, see October 13-14.

November 3-6

Electronic Fun Expo, New York City Coliseum. This is a consumer electronics show. Full particulars are available from Electronic Fun Expo, 350 East 81st St., New York, NY 10028, (212) 734-4440.

November 3-6

The 1983 National Home Electronics Show, Arlington Park Exposition Hall, Arlington Heights, IL. This show covers electronic equipment and technology ranging from home computers to telecommunications security systems. It's produced by Lincoln Merchandising Co. Inc., 1417 Milwaukee Ave., Chicago, IL 60622, (312) 276-2819.

November 5-6

The Fourth Annual San Diego Computer Fair, Scottish Rite Center, San Diego, CA. This fair features short technical sessions, programming and computer games contests, commercial displays, and user group displays. For additional information, contact the San Diego Computer Society, POB

81537, San Diego, CA 92138, (619) 565-8720.

November 5-7
Midwestern Educational Computer & Technology Conference, McCormick Inn, Chicago, IL. Exhibits, software demonstrations, seminars, and workshops will explore the theme "Higher Instructional Techniques in Education." For more information, contact the National Educational Computer Library, POB 293, New Milford, CT 06776, (203) 354-7760.

November 7-11
International Conference on Industrial Electronics—IECON '83, Hyatt Regency Hotel, San Francisco, CA. For information, contact Frank A. Jur, Bechtel Corp., 45 Fremont St., MS-45/17A26, San Francisco, CA 94109.

November 8-10
The Third Annual Software/Expo, Wembley Conference Centre, London, England. Conference topics range from computer-aided design to database management. Contact Software/Expo, Suite 400, 222 West Adams St., Chicago, IL 60606, (312) 263-3131.

November 8-11
Understanding Microprocessor-based Equipment and Troubleshooting, Holiday Inn-Pittsburgh/Sewickley, PA. For details, see October 11-14.

November 8-11
Wescon and Mini/Micro West-83, San Francisco, CA. A conference and exposition, Wescon covers a broad range of topics, including artificial intelligence, computer peripherals and simulation, and robotics. Mini/Micro serves the original equipment manufacturer community by exploring peripherals, processors, data communications, and software. Contact Electronic Conventions Inc., 8110 Airport Blvd., Los Angeles, CA 90045, (213) 772-2965.

November 9-10
Business-Expo, Philadelphia, PA. This exposition serves as a showcase for office equipment ranging from computers to coffee machines. More than 20 seminars are planned. Address inquiries to Business-Expo, 702 East Northland Towers, 15565 Northland Dr., Southfield, MI 48075, (313) 569-8280.

November 9-11
Cryptography and Data Security, Washington, DC. For details, contact Hellman Associates Inc., Suite 300, 299 California Ave., Palo Alto, CA 94306, (415) 328-4091.

November 9-15
Interkama 83, Düsseldorf, West Germany. This exhibition is designed for the instrumentation and automation industries. It's expected to attract more than 1000 exhibitors from over 25 countries. For complete details, contact Düsseldorf Trade Shows, 500 Fifth Ave., New York, NY 10110, (212) 840-7744.

November 11-13
Hometech '83, Exhibition Centre, Bristol, England. Personal computers and related equipment will be displayed. Contact Tomorrow's World Exhibitions Ltd., 9 Park Place, Clifton, Bristol BS8 1JP, England; tel: (0272) 292156.

November 14-17
AUTOFACT 5 Conference and Exposition, Cobo Hall, Detroit, MI. The focus of this event will be on CAD/CAM (computer-aided design/manufacturing) and the expanding technologies of computer-integrated manufacturing and the automated factory. More than 90 companies will exhibit CAD/CAM systems, computer graphics, software, industrial robots, and computer-based test and measurement systems. Concurrent technical sessions and tutorials will be held. Contact Gregg Balko, Society of Manufacturing En-

gineers, One SME Dr., POB 930, Dearborn, MI 48121, (313) 271-1080.

November 14-17
Canadian Computer Show & Conference, International Centre, Toronto, Ontario, Canada. Further information is available from Industrial Trade Shows of Canada, 20 Butterick Rd., Toronto, Ontario M8W 3Z8, Canada, (416) 252-7791.

November 15-17
SNA Architecture and Implementation, Sheraton Rolling Green Inn and Conference Center, Boston, MA. This seminar provides the working knowledge needed to design SNA (system-network architecture) networks and evaluate SNA-compatible products. Examples of how various protocols are used to control communications will be provided. Other topics include SNA functional layering and network elements. The fee is $650. Full details are available from Communications Solutions Inc., 992 Saratoga-Sunnyvale Rd., San Jose, CA 95129, (408) 725-1568.

November 15-17
The Technical Manager in an Engineering Environment, University of California, Berkeley. This course will deal with practical techniques for efficient management. It will include workshop sessions and clinics focusing on specific problems. The fee is $645. Further details are available from Continuing Education in Engineering, Department 670N, University of California Extension, 2223 Fulton St., Berkeley, CA 94720, (415) 642-4151.

November 15-18
Understanding Microprocessor-based Equipment and Troubleshooting, Ramada Airport Inn, Rochester, NY. For details, see October 11-14.

November 17-19
Ed-Com/Fall '83, Los Angeles, CA. This conference and exposition offers demonstrations, seminars, hands-on sessions, panels, and micro courses that address, evaluate, and analyze the development of computers in education. Hardware, software, and publishing companies will display items of interest. Contact Carol Houts, Judco Computer Expos Inc., Suite 201, 2629 North Scottsdale Rd., Scottsdale, AZ 85257, (800) 528-2355; in Arizona, (602) 990-1715.

November 17-19
The Fifth Annual Northeast Computer Show and Software Exposition, Hynes Auditorium, Boston, MA. This end user computer show offers nearly 500 displays of computers, peripherals, accessories, and software. More information is available from Northeast Expositions, 822 Boylston St., Chestnut Hill, MA 02167, (800) 841-7000; in Massachusetts, (617) 739-2000.

November 19
TC/TC: A Teachers College Conference on Teaching with Computers, Teachers College, Columbia University, New York, NY. As many as 60 teachers will present computer-based lessons that they have developed. Lessons include reading, music, art, mathematics, French, composition, and poetry for kindergarten through 12th grade. Workshops will also be featured. Contact the Office of Continuing Education, Box 132, Teachers College, Columbia University, New York, NY 10027, (212) 678-3065.

November 20-22
The Third Annual Purdue On-Farm Computer Use Conference and Trade Show, Purdue University Armory, West Lafayette, IN. Exhibits and demonstrations will be featured. Contact Stephen J. Resch, Continuing Education Administration, Stewart Center, Purdue University, West Lafayette, IN 47907, (317) 494-2755.

November 20-24
The Third Gulf Computer Exhibition and the **Gulf Office Exhibition**, International Center, Dubai, United Arab Emirates. These concurrent exhibitions are designed to promote all aspects of computer technology and computer-related office equipment. Information is available from MABCO Inc., Suite 308, 739 Boylston St., Boston, MA 02116, (617) 536-3442.

November 28-December 2
Welcome to the World of Personal Computing, Fort Lauderdale, FL. For details, see October 31-November 4.

November 29-December 2
Understanding Microprocessor-based Equipment and Troubleshooting, Sheraton Greenway Inn, Phoenix, AZ. For details, see October 11-14.

December 1983

December 6-8
The Seventh International Online Information Meeting, Cunard Hotel, London, England. This conference offers presentations that address current problems and opportunities facing those who provide information in business, industry, government, and education. Topics on the agenda include networks, costs of online and videotex systems, software, and user information. Products, services, systems, and publishing organizations will exhibit. Further details are available from the Organizing Secretary, International Online Information Meeting, Learned Information Ltd., Besselsleigh Rd., Abingdon, Oxford OX13 6LG, England; tel:

(0865) 730275; Telex: 837704 INFORM G.

December 6-8
The Software Maintenance Workshop, Naval Postgraduate School, Monterey, CA. Topics of interest include definitions of software maintenance, tools for software and database maintenance, and program evolution. Contact the IEEE Computer Society, Suite 300, 1109 Spring St., Silver Spring, MD 20910, (301) 589-8142.

December 6-8
Business-Expo, Dallas, TX. For details, see November 9-10.

December 6-9
Understanding Microprocessor-based Equipment and Troubleshooting, Capitol Plaza Holiday Inn, Sacramento, CA. For details, see October 11-14.

December 8-11
Southeast Computer Show and Office Equipment Exposition, Atlanta, GA. Contact Dee Harris, Computer Expositions Inc., POB 3315, Annapolis, MD 21403, (800) 368-2066; in Maryland, (800) 492-0192.

December 9-15
Educatec 83, Porte de Versailles, Paris, France. This is the first French exhibition of computerized teaching and training equipment, materials, and techniques. Meetings, symposiums, and debates on educational technologies and professional training will be held. For details, contact Edit Expo International, 4 rue de Chéroy, 75017 Paris, France; tel: (1) 294 05 60; Telex: 641284 F EDIXPO.

December 12-15
Conference on Human Factors in Computing Systems—CHI '83, Boston, MA. Papers, sessions, and tutorials will focus on system usability. Additional information is available from Raoul N. Smith, GTE Laboratories, 40 Sylvan Rd., Waltham, MA 02254, (617) 466-4044.

December 14-15
Hi Tech Update '83, Delta Ottawa Hotel, Ottawa, Ontario, Canada. An annual update on state-of-the-art high technologies. Contact Marg Coll, 1138 Sherman Dr., Ottawa, Ontario K2C 2M4, Canada, (613) 225-4229.

December 15-16
Personal Computer Local Networks, San Francisco, CA. This is the final program in the four-part Architecture Technology Corporation 1983 Forum Series. This program will bring together manufacturers and users of local network schemes to exchange information in an informal setting. The format includes presentations, panel discussions, and a technological summary. The fee is $395. For further information, contact the Architecture Technology Corp., POB 24344, Minneapolis, MN 55424, (612) 935-2035. ■

In order to gain optimal coverage of your organization's computer conferences, seminars, workshops, courses, etc., notice should reach our office at least three months in advance of the date of the event. Entries should be sent to: Event Queue, BYTE Publications, POB 372, Hancock, NH 03449. Each month we publish the current contents of the queue for the month of the cover date and the two following calendar months. Thus a given event may appear as many as three times in this section if it is sent to us far enough in advance.

UNIX AND UNIX-RELATED PRODUCTS

Unix Benchmarks Measure System Performance

Aim Technology markets a portable Unix Benchmark tape to OEMs and manufacturers. This benchmark, which measures actual end-user throughput and multiuser performance, consists of nine distinct tests made up of shell scripts with C language programs that run unattended in any Unix-based system. Each test prints comparative graphs and raw measurements. The Benchmark tests Version 7 Unix command-list completeness, C compiler efficiency, and several aspects of hardware performance applicable to Unix Version 7 and System III. Measurements of the central processor include looping and floating-point calculations. The benchmark examines disk transfer speeds for various record lengths. Compiler optimization is probed for short, integer, and long types. Memory/paging throughput and interprocess communications are measured. Multiuser performance is examined for simulated multiple users doing sorting and editing.

The tests are provided on nine-track, 1600-bpi "Tar" tape with documentation and sample benchmarks. The entire process takes approximately 45 minutes; about 15 pages of reports are produced. For licensing information, contact Aim Technology, Suite 199, 3333 Bowers Ave., Santa Clara, CA 95051, (408) 727-3711.

Circle 650 on inquiry card.

Custom Menu Program for Unix

HCR/Menu Shell lets you custom design menus for Unix. Any text editor can be used to make a file of menus and the associated commands. The menu does not add any overhead to the operating system because it becomes an enhancement to the Unix shell. After your menu is installed, it appears at the top of the screen. The menu structure can be bypassed for direct issuing of commands from the Unix shell. User prompts and restricted access can be written into the menu, and fields can be updated from other programs.

Pricing for the HCR/Menu Shell ranges from $500 to $1000, depending upon the central processor to be supported. Further details can be obtained from Human Computing Resources, 10 St. Mary St., Toronto, Ontario M4Y 1P9, Canada, (416) 922-1937.

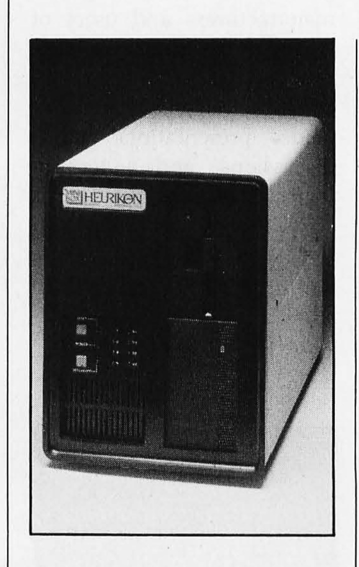
Circle 651 on inquiry card.

Relational Database Designed for Unix

Unify, a fully relational database designed for the Unix operating system, provides queries and a purported 10 to 100 percent performance improvement. The performance improvement is achieved through the use of a variety of access methods, such as pointers, hashing, and B-trees, that maximize performance regardless of file structure. A built-in optimizer automatically evaluates each query and selects the expression/evaluation sequence, join order, and access method that will provide the fastest response. Other features include a choice of user interface components, including query-by-forms, SQL, and a general-purpose driver that allows access to files through either a host language or nonprocedural tools.

The single end-user price for Unify is $2995. OEM and quantity discounts are available. Contact Unify Corp., 9570 Southwest Barbur Blvd., Portland, OR 97219, (503) 245-6585.

Circle 652 on inquiry card.



Unix Workstation Has Built-in C Compiler

Minibox, Heurikon Corporation's multiuser Unix workstation, is built on the MC68000 microprocessor and comes with an integral C compiler. Four or six Multibus cards, single or dual floppy-disk drives, and 31.2 to 140 megabytes of Winchester hard-disk storage are packed into the Minibox, which measures 10½ inches wide, 21 inches deep, and 14½ inches tall. This workstation is built around Heurikon's HK68 microcomputer, which provides the central processor, floppy-disk controller, Winchester and tape interfaces, four to eight serial ports, and 750K bytes of RAM in two Multibus card slots. Minibox has two forward and two rear disk-drive bays. The forward bays can be used for one or two 5¼-inch floppy-disk drives on top of a 5¼-inch Winchester drive. The rear bay can be fitted with one or two 5¼-inch Winchesters.

Up to 420 megabytes of Winchester disk-storage and a graphics card are available as options. Minibox costs from $12,000 to $20,000, depending on disk subsystems. For full specifications, contact Heurikon Corp., 3001 Latham Dr., Madison, WI 53713, (800) 356-9602; in Wisconsin, (608) 271-8700.

Circle 653 on inquiry card.

Uniflex BASIC Takes Advantage of Unix

Uniflex BASIC 68000 is available for OEM licensing. This system runs under Unix and offers several features that take advantage of Unix. Uniflex, modeled after DEC's BASIC Plus, lets you access system time and date, the running number, and the calling terminal number. Uniflex supports automatic record locking and shared text when these features are available under Unix. Its floating-point mathematics routines provide 16.6 digits of precision, and the built-in mathematics functions are accurate to a minimum of 13.5 digits. An "approximately equal to" operator can be used to compare floating-point values.

File sizes of up to 1 billion bytes are allowed. Three types of files are supported: sequential, record I/O, and random files accessed by virtual arrays. The length of each record can range from 1 byte to 16,383 bytes. Any record in an I/O file can be randomly read or written on request. The data in each record are defined as ASCII characters, binary numeric data, or a combination of the two. Virtual arrays allow a program type to store a data array in a disk file. Other features include an "exec" statement that allows the BASIC programmer to call another Unix program from an executing BASIC program, a mechanism for trapping errors, a compile command that allows BASIC to save programs on disk in a concise form that has a source that cannot be recovered, and the ability to modify an existing line without retyping. A single command loads BASIC or a specified BASIC program and begins execution of the program.

For more information on Uniflex BASIC 68000, contact Technical Systems Consultants Inc., Providence Rd., Chapel Hill, NC 27514, (919) 493-1451.

Circle 654 on inquiry card.

Directory Lists Unix Software

Onager Publishing has produced a directory of applications software available for the Unix operating system. This directory lists more than 20 categories of software with details on function, cost, size, and availability. Information on manufacturers, such as size and years in business, is also provided.

Onager Publishing service seeks to be a centralized source of Unix information for OEMs and system integrators. For further information, contact Onager Publishing, Suite 204A, 289 South San Antonio Rd., Los Altos, CA 94022, (415) 941-2060.

Circle 655 on inquiry card.

Seminars Cover C and Unix

Three five-day seminars on C and Unix topics are available from Plum Hall for unlimited use within companies. Through a sublicensing agreement, an interested organization that wants to present C or Unix courses to its customers and employees can use these field-tested training materials.

The "C Programming Workshop" is an introductory course for programmers. For experienced C programmers, "Advanced C Topics" covers such subjects as efficiency, portability, and other software engineering topics. Software development is emphasized in the "Unix Workshop," which is designed for introductory audiences.

A single-course, unlimited license costs $10,000. For more information, contact Plum Hall Inc., 1 Spruce Ave., Cardiff, NJ 08232, (609) 927-3770.

Circle 656 on inquiry card.

Review Serves as Unix Info Center

Unix Review serves as a clearinghouse of information on all aspects of the Unix operating environment as well as Unix-inspired operating systems. It acts as a bridge between the diverse communities of Unix users. It offers research reports, product reviews, user group reports, and featured articles.

Unix Review is produced bimonthly. Annual subscriptions are $23; overseas subscriptions cost $43 (surface mail). The newsstand price is $3.95. For details, contact Review Publications, 2711 76th Ave. SE, Mercer Island, WA 98040, or call operator 965 at (800) 824-7888; in California, (800) 824-7777. Residents of Alaska and Hawaii can call (800) 824-7919. For residents of Washington state or for retail dealer information, call (206) 232-6719.

Circle 657 on inquiry card.

Multitasking Operating System Compatible with Unix Software

A multitasking operating system that's compatible with Unix software and designed for networking microcomputers has been announced by Lantech Systems. Unetix is a standalone system that lets you simultaneously display and work with up to 10 active windows per screen. You can transfer data or text from one window to another, or you can zoom in on a specific window. Unetix also features an emulator to support both MS-DOS and Unix applications software.

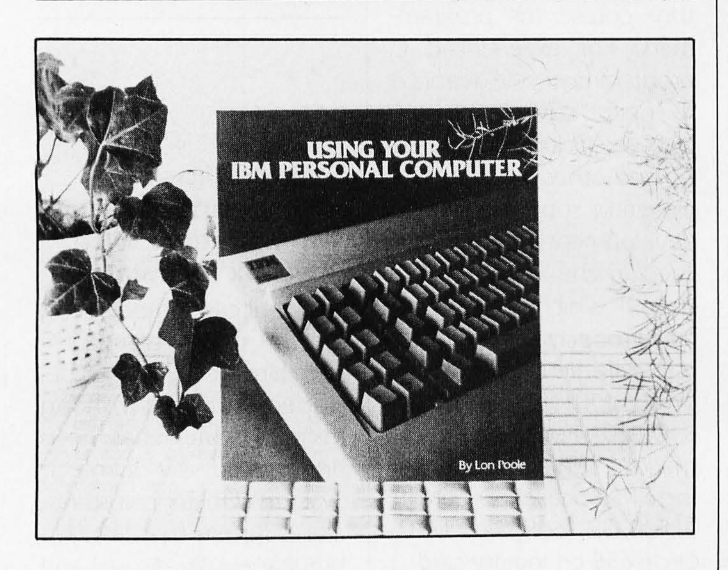
Unetix-DFS is the networking version of Unetix. It uses a distributed filing system for transparent remote file and device access. Unetix-DFS is compatible with Plexus Computers' Unix System III Network Operating System. Through Unetix-DFS's virtual terminal capability, you can access the power of an external system. You can also attach portions of file systems from a remote computer to your local file hierarchy. It operates through a high-level communications protocol that's

independent of network hardware.

Unitex is also available with a virtual file system. For full details, contact Lantech Systems Inc., 9625 Wendell Rd., Dallas, TX 75243, (214) 340-4432.

Circle 658 on inquiry card.

PUBLICATIONS



New Book Explains IBM PC Operation

Using Your IBM Personal Computer, by Lon Poole, is a Howard W. Sams & Company publication. Subjects covered in the book include the elements of system configuration, using PC-DOS, and how to boot application programs. BASIC programming and built-in utilities for BASIC programmers are explained. Also discussed are keyboard input, the video-display screen, printer output, disk files, graphics, sound, and control. A 12-page index, four appendixes outlining commands and codes that are displayed or used with the IBM, and a removable reference card summarizing BASIC and PC-DOS commands are provided.

Using Your IBM Personal Computer is 326 pages long. It costs $16.95 at most bookstores. For more information, contact Howard W. Sams & Co., 4300 West 62nd St., Indianapolis, IN 46206, (317) 298-5400.

Circle 659 on inquiry card.

Software for 68000 Described in Catalog

The **Motorola Microprocessor Software Catalog** contains cross-referenced listings of software available for Motorola's 16-bit MC68000 microprocessor. It provides information on Unix derivatives and look-alikes, non-Unix operating systems, languages, applications and systems software, and cross software. Product data provided includes information on host system requirements, operating systems supported, special features, and brief product overviews. Vendor data includes company, address, and key contact. The lists are alphabetically arranged by company. For further details, inquire about catalog number BR126R1 by writing to Motorola Microsystems Inc., Microprocessor Software Catalog, 2900 South Diablo Way, Tempe, AZ 85282.

Circle 660 on inquiry card.

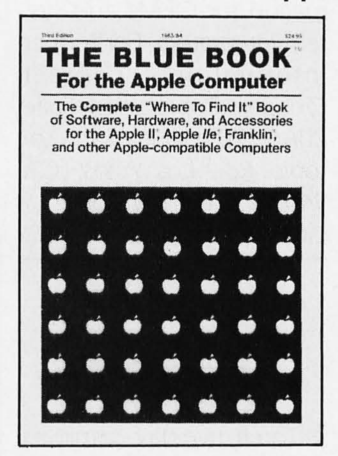
VLSI and Systems Interaction Explored

Hardware and Software Concepts in VLSI, edited by Guy Rabbat, explains the interaction between system and chip design. Large-scale embedded systems and the effect of technology on system design are examined. Discussions of microprocessor system architecture focus on the use of VLSI technology, hardware algorithms for string processing, VLSI chip architecture, and VLSI designs based on the use of programmable-logic array macro instructions. Also explored are masterslice bipolar design, computer-aided design methods for gate arrays, gallium-arsenide technology, electron-beam testing techniques for microprocessors, and design verification and logic simulation in VLSI.

Complete with illustrations, this 512-page book costs $42.50 and can be ordered directly from Van Nostrand Reinhold, Mail Order Service, 7625 Empire Dr., Florence, KY 41042.

Circle 661 on inquiry card.

Blue Books on Apple/Commodore Products

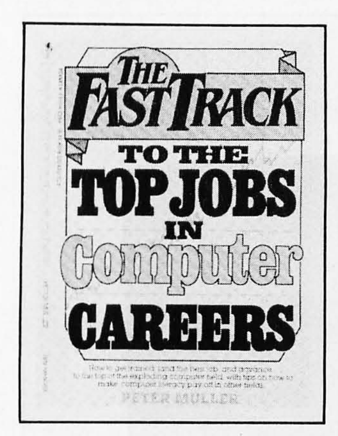


The Blue Book for the Apple Computer and **The Blue Book for the Commodore Computer** are marketed by WIDL Video Publications. Both books serve as a directory of hardware, software, and accessories for these popular computers. Source indexes, an alphabetic program index, and keyword indexes are provided.

The Apple **Blue Book** costs $24.95, and the Commodore **Blue Book** is $17.95. Other editions are available for the Atari and the IBM Personal Computer. Contact WIDL Video Publications, 5245 West Diversey, Chicago, IL 60639, (312) 622-9606.

Circle 662 on inquiry card.

What's New?



Computer Career Guide

The Fast Track to the Top Jobs in Computer Careers is a beginner's guide by Peter Muller to selecting and pursuing a career in computers. Chapters cover such areas as understanding the field, getting started in high school or college, and change of careers. An appendix of data-processing organizations and associations, a list of career reference sources, and a glossary of computer terms supplement the presentation.

The Fast Track to the Top Jobs in Computer Careers is published by GD/Pedigree Books. It costs $4.95 and is available at many bookstores or from Redtree Associates, 1740 N St. NW, Washington, DC 20036.

Circle 663 on inquiry card.

Second Edition of Ethernet Handbook Released

The second edition of The Ethernet Handbook has been released. This 532-page, perfect-bound book contains selected product descriptions for more than 50 vendors, Ethernet 2.0 specifications, and articles on Ethernet, personal computers, and the marketing of Ethernet through retail stores. The components of the Ethernet/personal computer connections are discussed, and case studies and vendor company names and contacts are included.

The Ethernet Handbook costs $100 (prepaid). It's available from Shotwell & Associates, 130 Golden Oak Dr., Portola Valley, CA 94025, (415) 851-077.

Circle 664 on inquiry card.

Micro Review Available on Rolodex

Each month, Educational Micro Review surveys and categorizes more than 400 articles from over 25 microcomputer-related publications. Selections include hardware and software reviews and full bibliographic data. An additional feature of the publication is cross-referencing of hardware and software reviews. The Review is now available on 3- by 5-inch index and Rolodex cards designed for authors and libraries. These cards provide access to articles on specific topics and a means of accumulating an article database.

A year's subscription to the Educational Micro Review costs $36. The single-issue price is $5. Rates for the index and Rolodex card versions are $55 for individual review categories (book, software, and hardware). A full deck costs $120. Contact Educational Micro Review, POB 14393, Austin, TX 78761, (512) 345-7739.

Circle 665 on inquiry card.

BASIC/Logo Programming Guide

Written for novice programmers, Dr. James L. Poirot's 40 Easy Steps to Programming in BASIC and Logo uses a learn-by-doing approach. Easy-to-follow steps are said to guide readers through simple Apple II programming exercises.

40 Easy Steps to Programming in BASIC and Logo costs $3.95 and is available from the Sterling Swift Publishing Co., 7902 South I-35, Austin, TX 78744, (512) 282-6840.

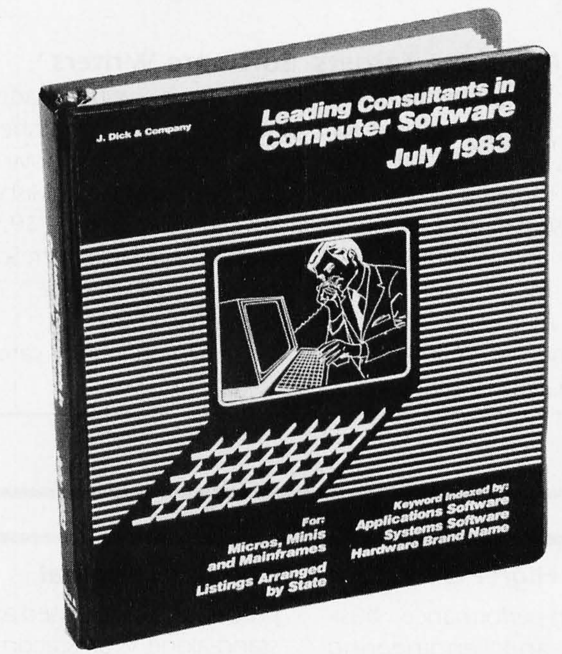
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Ada Tutorial

Tutorial: The Ada Programming Language contains many of the early papers on Ada and its environment. Designed for engineers and computer scientists, this book covers such topics as the history and current status of the language, how to prevent errors, environments for Ada, and portability. A glossary and bibliography are provided.

Written by Sabina H. Saib and Robert E. Fritz, Tutorial: The Ada Programming Language is published by the Computer Society of the Institute of Electrical and Electronic Engineers, POB 80452, Worldway Postal Center, Los Angeles, CA 90080, (714) 821-8380.

Circle 667 on inquiry card.



Directory of Software Consultants

A directory of software consultants and custom programmers, Leading Consultants in Computer Software has been compiled by J. Dick and Company. This directory lists nearly 1250 consultants, indexed by the computer models and languages

with which they work and the applications and systems software in which they have expertise. More than 75% of the consultants are said to offer modem support to their clients. Index listings are arranged by city and state under approximately 850 keywords, ranging from accounts payable to Zilog. Additional data furnished includes address, telephone number, hardware, chips programmed, years of experience, and references.

Available for $67 (postage paid), **Leading Consultants in Computer Software** can be ordered directly from J. Dick & Co., 500 Hyacinth Pl., Highland Park, IL 60035, (312) 433-0824.

Circle 668 on inquiry card.



Nearly 288 Printer Ribbons Described in Catalog

A 16-page catalog detailing 288 ribbons for computer printers can be obtained from Aspen Ribbons Inc. Photographs and descriptions help users and distributors identify the correct ribbon for the printer. An updated price list is included with each catalog. For more information, contact Aspen Ribbons Inc., 1700 North 55th St., Boulder, CO 80301, (800) 525-0646; in Colorado, (303) 444-4054.

Circle 669 on inquiry card.



Magazine Targets Software Writers

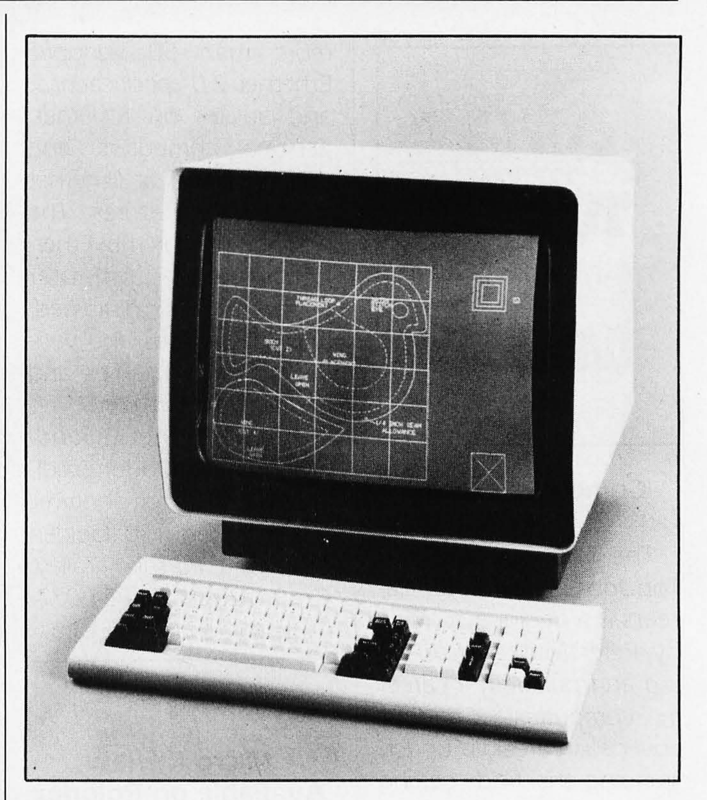
The Software Author is a bimonthly magazine for writers of computer software. Targeted at both the professional and amateur writer, this publication features market listings of book, magazine, and program publishers. It provides information on copyrights, interviews with leading authors and publishers, and offers tips on how to be your own publisher. Subscriptions cost $9.95 and are available from Softquest, POB 44122, Tacoma, WA 98444.

Circle 670 on inquiry card.

TERMINALS

High-Performance Graphics Terminal

High-performance business and engineering graphics can be generated with the CGT/680 color graphics terminal from General Digital Industries. The CGT/680, based on the Motorola MC68000 processor, can be used as a stand-alone workstation, a computer terminal, or a CAD/CAM front-end. It uses a 19-inch Panasonic raster-scan CRT. In its graphics mode, up to 16 colors can be displayed from a palette of 512 in a 640 by 480 format. Lookup tables let you switch colors quickly. Zoom, pan, and blink are standard graphics attributes. For alphanumerics, the CGT/680 gives you displays of up to 48 lines by 80 characters. Attributes include double-height and double-width characters, blink, reverse video, and underline.



System hardware comprises 4K bytes of RAM and 16K bytes of EPROM. A four-slot VME backplane offers two slots for expansion. Two synchronous/asynchronous I/O ports can support SDLC/HDLC protocols.

A low-profile QWERTY keyboard equipped with a numeric keypad, cursor pad, and 20 special-function keys is available. A trackball, touch-sensitive screen, 4K- and 16K-byte memory modules, SDLC/HDLC protocols, a software-development system, and emulation packages for VT-100, ISC 8001, and Calcomp 960 displays are available as options. Single-unit prices begin at $4495. Contact General Digital Industries Inc., 7702 Governors Dr., Huntsville, Al 35805, (205) 837-8305.

Circle 671 on inquiry card.

Multiposition ASCII Display

An ASCII video-display terminal is available from Prima International. The Prima 30 is a multiposition, tilt-and-swivel pedestal monitor with a low-profile, detached keyboard. Green and amber etched nonglare screens are available. Prima displays 80 characters by 24 lines with a twenty-fifth status line and transmits at speeds of up to 19,200 bps in block or con-

versational modes. It emulates Adds Viewpoint, Lear Siegler ADM3A, and Hazeltine 1500 terminals.

Other emulation modes are available. The Prima 30 costs between $300 and $400. For further information, contact Prima International, 3255 Kifer Rd., Santa Clara, CA 95051, (408) 732-4620.

Circle 672 on inquiry card.

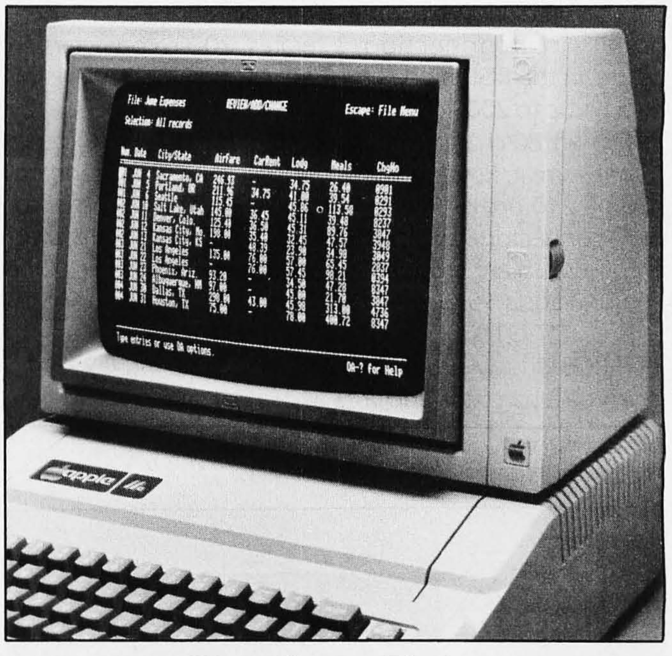


Display Aimed at Professionals

The Guru display terminal is aimed at the professional who wants an ANSI-standard terminal with maximum data storage and display capabilities. The Guru provides more than 28K bytes of display memory, or approximately six full typewritten pages, which can be scrolled or zoomed horizontally and vertically. User-selectable memory formats can contain as many as 66 lines of up to 170 columns. A 15-inch nonglare green-phosphor display is used. The detached keyboard features 38 keys programmable on 60 levels with any ASCII string, with local-only, send-only, and repeat control. Smooth scroll, rapid editing with local move capability, forms-filling functions, pause key, Meta key, and an RS-232C printer interface with local and remote print and copy functions are standard. English identifiers are provided for all setup modes.

Options include a tilt-and-swivel accessory, a portrait display providing vertical screen orientation, a DEC mode for VT100/VT52 software compatibility, and 768- by 600-pixel vector graphics capabilities. The suggested retail price is $2395. Contact Ann Arbor Terminals Inc., 6175 Jackson Rd., Ann Arbor, MI 48103, (313) 653-8000.

Circle 673 on inquiry card.



Monochrome Display Complements Apples

Apple Computer is now marketing a monochrome video display that complements the physical appearance of its Apple II, II Plus, and IIe computers. This 12-inch P31 green-phosphor monitor features high-resolution text and graphics, a high-contrast screen, and a tilt mechanism. Operator controls include contrast, vertical hold, and vertical amplitude and brightness. The display format is 24 by 80. The suggested retail price is $229. For the name of your nearest Apple dealer, contact Apple Computer Inc., 20525 Mariani Ave., Cupertino, CA 95014, (800) 538-9696; in California, (408) 973-2042.

Circle 674 on inquiry card.

Color Monitors Use Data-Grade Picture Tubes

Two RGB color displays were recently introduced by Panasonic. Both units incorporate data-grade picture tubes and offer full compatibility with Apple II, Panasonic JR-200, and IBM PCs. Common features include built-in audio systems and the ability to generate 16 colors.

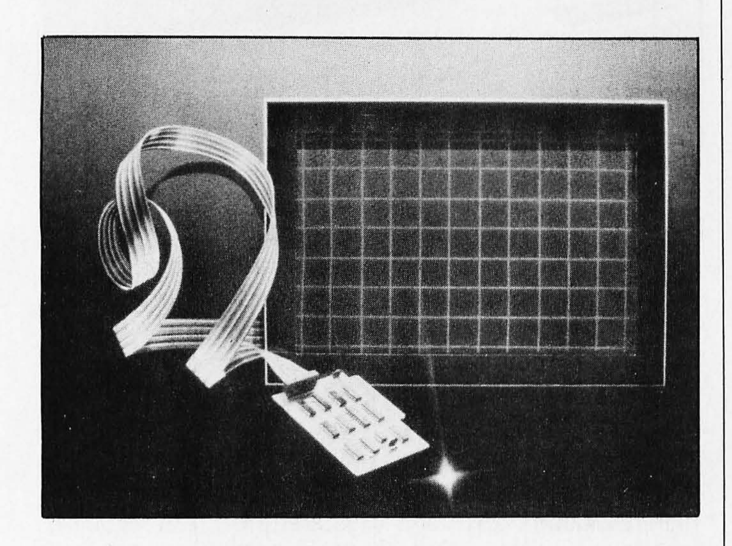


A 13-inch (diagonal) RGB/composite display, the DT-D1300D features an etched, nonglare, dark-faced CRT. It accepts a composite-video input and displays of up to 1000 characters in a 40 by 25 format. Its alternate RGB input features a multipin in-

put connector with optional interconnection cables. In the RGB mode, it displays up to 2000 characters in an 80-character by 25-line format. Resolution is 430 by 240 pixels. A looping connector and an on/off switch are provided. The unit costs $540.

The DT-D1000G 10-inch RGB display has built-in interface circuitry and a multipin connector. It generates 2000 characters in an 80 by 25 display and offers a resolution of 350 by 240 pixels. A universal power supply is standard. The DT-D1000G lists for $450. Full details are available from Panasonic, One Panasonic Way, Secaucus, NJ 07094.

Circle 675 on inquiry card.



Touch-Sensitive Display for Apples

Computer Technology Associates markets a touch-sensitive display screen for the Apple Monitor III and other 12-inch monitors. The CTA 500X Touch Bezel and Interface provides instantaneous response to onscreen touch commands and is capable of emitting continuous responses for tracking moving stimuli. It uses infrared emitter-sensor array technology and offers 96- by 64-point resolution. The Interface card plugs into an Apple peripheral slot, and, once initiated, the screen remains continually touch-sensitive. All communications are hardware-controlled; communications software is not required. Applesoft BASIC can read and write the X,Y coordinates of the moving command without modification.

The CTA 500X has a suggested retail price of $695. Quantity discounts are available. For further information, contact Computer Technology Associates, 1704 Moon NE, Albuquerque, NM 87112, (505) 298-2140.

Circle 676 on inquiry card.

COMMUNICATIONS

Datamizer Doubles Throughput

Datamizer is a multiplexing data-compression unit. When installed between data terminal equipment and a standard 9600-bps modem, it allows twice the volume of data to be transmitted over standard telephone lines at speeds as high as 19,200 bps. Datamizer uses a data-compression algorithm called SCC Tabling, which is an auto-adaptive form of Huffman Encoding. SCC Tabling lets Datamizer analyze any EBCDIC or ASCII data character and convert it to a shorter subcode based on its relative frequency in the data stream. Operating in pairs, one at each end of a full-duplex line, both Datamizers send and receive data while continually updating the SCC frequency table for maximum throughput. The receiving unit uses the frequency information to decode and expand subcodes into standard 8-bit code sets. This method is purported to achieve error-free compression ratios of 2:1 or better. Datamizer is not dependent on communications protocols, nor does it require set-up programming. Its operation is transparent.

Datamizer also serves as a statistical multiplexer, using dynamic band allocation. Each of its four channels can multiplex a different half- or full-duplex protocol at an independent rate. Transmission rates can be divided into two 9600-bps channels or four 4800-bps channels. All four inputs can be set to 9600 bps, resulting in an aggregate input of 38,400 bps.

In single units, Datamizer costs $4950. Quantity discounts are offered. Full specifications are available from Symplex Communications Corp., Suite 17, 2002 Hogback Rd., Ann Arbor, MI 48104, (313) 973-1164.

Circle 677 on inquiry card.

Communications Board

Voice/computer/telephone communication is possible with the V. C. T. board from Unisound. The communications board is said to give Apple owners access to an unlimited vocabulary, languages, and tonal varieties. It combines the ability to place and receive calls automatically with a Touch-Tone decoder for entering and retrieving data over telephone lines. Six I/O ports let you monitor and control such accessories or interfaces as appliances and security systems. Software for developing and storing speech messages is supplied. An answering-service program and a BASIC interpreter that adds new commands to Applesoft are also furnished.

The V. C. T. board costs $350. For more information, contact Unisound Corp., 3060 Harding Ave., Santa Clara, CA 95051, (408) 554-6227.

Circle 678 on inquiry card.

Self-contained Direct-connect Modem

Timecor's Operator, a 110/300-bps direct-connect modem, is hardware-compatible with the Apple II/IIe and II Plus, Franklin Ace 100 and 1000, and the Basis 108. Its foremost features are half-and full-duplex operation, auto-answer and auto-disconnect, and the ability to work with rotary-pulse and Touch-Tone telephones. This self-contained Bell 103-compatible device allows one-way or simultaneous sending and receiving. It fits into any Apple slot except zero and is compatible with such communication software as ASCII Express Pro, Visiterm, Modem Magic II, and Z-Term.

The Operator, available factory-direct for $159.95, comes with documentation and start-up software. Contact Timecor, Four Longfellow Place, POB 8928, Boston, MA 02114, (617) 720-4090. Visa and Master Card owners can order by calling (800) 824-7888, operator 52.

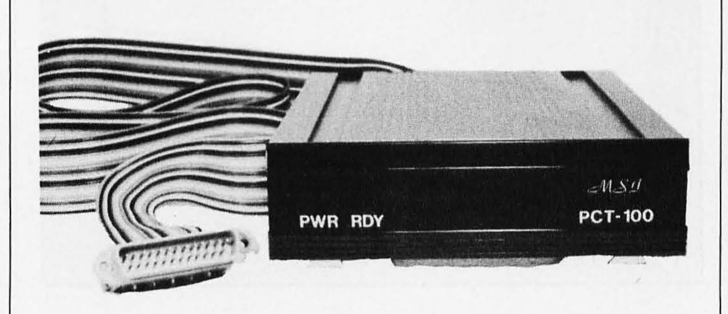
Circle 679 on inquiry card.

Web Network for Kaypro

The Web lets you weave Kaypro computers into a network. Each computer in the network acts as a file server as well as a local processor, and any linked user can share data stored on the disk drive of another Kaypro or direct output to a remote printer. Users can send and receive mail, messages, and files, log on to drives on another machine, and run programs. The Web is a baseband CSMA/CD-CA network operating at just over 125,000 bps. Connections are made with conventional telephone cables. OPSnet, the networking software, supports most CP/M 2.2 programs.

Web can be configured using any combination of Kaypro computers, including the II, 4, 10, and Kaynet, which has built-in network capabilities. Complete with manual, hardware, cables, and software, the networking option costs $195. For more information, write to Kaypro Corp., POB N, Del Mar, CA 92014.

Circle 680 on inquiry card.



RS-232C Interface Has Communications Language

Method Systems' PCT-100 is a user-configurable RS-232C interface with an internal communications translator language—called CTL—that lets you configure the interface to perform most translation algorithms. The PCT has two bidirectional RS-232C ports that allow it to be placed inline with any RS-232C link. It can be used for terminal or printer emulation or for providing compatibility and macro function keys for word processing, accounting, and other software. It offers type-ahead and data buffering capabilities, data-rate adaptation, and handshake protocol conversion.

Offered as a ready-to-install printed-circuit board or as a stand-alone unit, the PCT-100 costs $369, without power supply. Contact Method Systems Inc., 19751 South Lakeshore Blvd., Euclid, OH 44119, (216) 531-0404.

Circle 681 on inquiry card.

IBM PC XT Local-Network Scheme

Novell's Sharenet X allows as many as 255 IBM PC XTs to share up to 320 megabytes of storage. The network protocol is CSMA/CD (Carrier Sense Multiple Access), and the data-transfer rate is 1.43 megabits per second. The Sharenet operating system provides the file server with support for multiple DOSes sharing the network and file space, a means for managing the functioning of multiple computers in the same directory simultaneously, file security, and support of spooled printers and station-to-station pipes. A single 256K-byte IBM PC XT functions as a file server in the Sharenet scheme, and each satellite must be equipped with a network interface module. Maximum linear coaxial (RG59) cable length is 4000 feet.

Electronic mail is available as a $995 option. The operating system costs $1495, and network interface modules are $695. For an information packet, contact Novell Inc., 1170 North Industrial Park Dr., Orem, UT 84057, (800) 453-1267; in Utah, (801) 226-8202.

Circle 682 on inquiry card.

Microcom Networking Protocol

The Microcom Networking Protocol (MNP) is said to be the first data-communications protocol to allow file transfer to and from a variety of microcomputers over ordinary telephone lines. The protocol, based on the Open Systems Integration (OPI) model, features flow control, data transparency, error detection, and retransmission. The architecture provides reliable, flow-controlled data transfer on point-to-point connections. Data can be transferred both as streams of bytes and as files. The encoding protocol information is byte-oriented throughput, which facilitates implementation of MNP in program-

ming languages on computers that do not provide bit manipulation. The file-transfer protocol is inherently half-duplex or command responsive. The hardware requirements are a 212A or 103 modem and voice-grade telephone cables.

Currently, the MNP protocol has been employed on such computers as the Apple, the Radio Shack, and the IBM PC. It has also been used in Microcom's line of networking modems. MNP is available for a $2500 licensing fee. Full particulars can be obtained from Microcom Inc., 1400A Providence Highway, Norwood, MA 02062, (617) 762-9310.

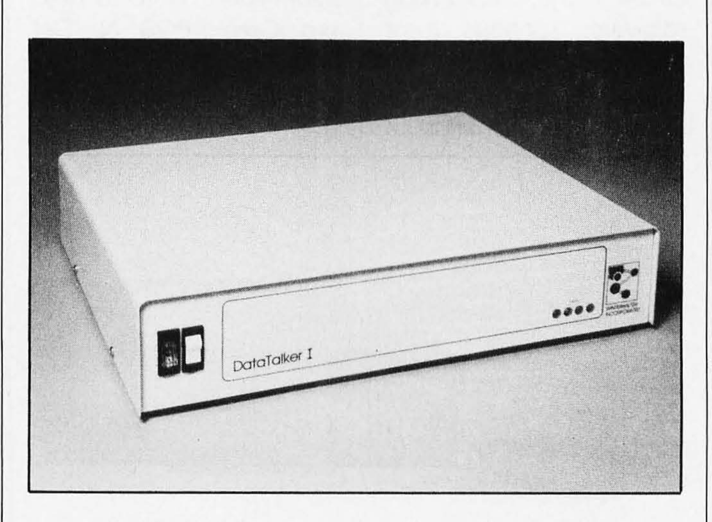
Circle 683 on inquiry card.

Database Covers Industrial-Site Development

Sitenet is a free online database delivering instant site data to industrial facility planners and corporate real estate executives. Sitenet's files contain information on tax incentives for industrial development, more than 5000 contacts in area economic development, and a directory of office and industrial parks. A new-plant file provides data on more than 1000 worldwide industrial expansion projects and details on the amount of investment, acreage, and square footage of the undertakings. An interactive inquiry mode lets you request additional information online from development corporations participating in the network. Blocks of information provided by state development agencies, railroads, and utilities are available. Hard-copy reports from the database can be ordered.

For more information, contact Conway Data Inc., 1954 Airport Rd. NE, Atlanta, GA 30341, (404) 458-6026.

Circle 684 on inquiry card.



Intelligent Communications Processor

Winterhalter's Datatalker I is an intelligent front-end communications processor for emulating such remote batch and interactive terminals as the IBM 3780, 2780, and 3276 using IBM Binary Synchronous Protocol. It contains two network programs for interactive and remote batch emulation, both of which offer full bisync emulation and on- and offline diagnostics. A communications manager assumes responsibility for controlling the line between the microcomputer and the host system. An applications program, executed on the microcomputer, acts as an interface between the microcomputer and Datatalker and allows custom user programs to interface with the host. This arrangement frees the microcomputer of all communications overhead and overloads.

Datatalker hardware consists of one modem port, a diagnostics port, and an asynchronous serial link with internal clock generation. All ports are RS-232C serial interfaces. The modem and diagnostics ports can be programmed for internal or external clock generation and are byte or bit synchronous or asynchronous. Internal clock speeds range from 110 to 19,200 bps.

The Datatalker I is a desktop unit that weighs about 7 pounds. The suggested list price is $995. Further details are available from Winterhalter Inc., 3853 Research Park Dr., Ann Arbor, MI 48104, (313) 662-2002.

Circle 685 on inquiry card.

Apple/Atari Interface

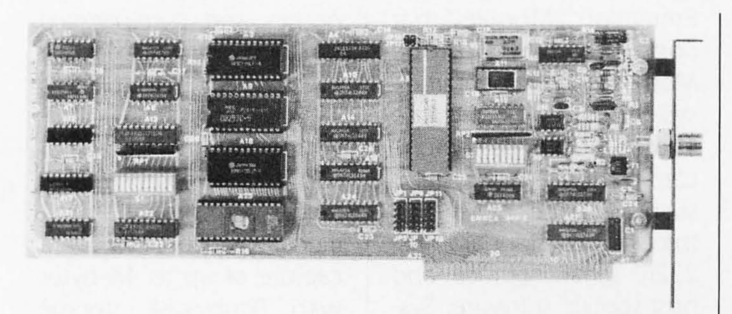
Prowell Computer Services markets an interface that allows disk files to be transferred between Atari 400/800 and Apple II, II Plus, and IIe computers. A cable that connects to the joystick ports on both computers provides the means for sending and receiving source programs and data files.

The interface comes in two versions. The Model 1 is designed for the Apple II/II Plus. The Model 2 includes the cable and a 9-pin connector that mounts on the back of the IIe. They cost $75 and $90, respectively. A 4-foot extension cable is also available. Contact Prowell Computer Services, Suite 325, 4974 North Fresno, Fresno, CA 93726, (209) 227-4917.

Circle 686 on inquiry card.

Arcnet-PC Network Controller

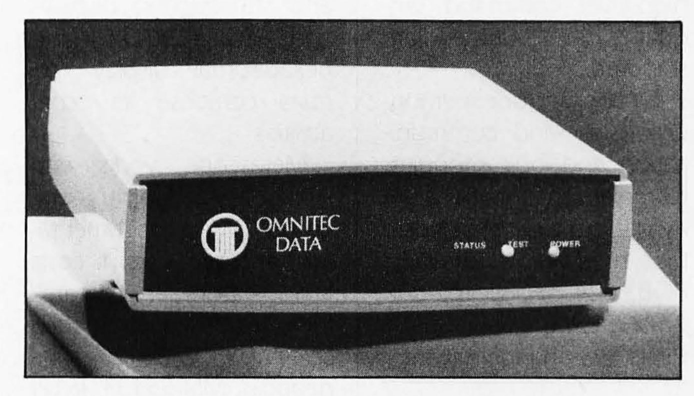
The ARC-PC local-area network controller board is a simplified interface between IBM Personal Computers and Datapoint's Arcnet token-passing network. Standard Microsystems' single-chip COM 9026 network controller and COM 9032 network transceiver LSI circuits handle Arcnet protocols. This single printed-circuit board has an onboard 2K-byte data-packet buffer that accommodates up to four pages of packet storage and can be dynamically defined for double-buffering of transmit and receive



functions. An 8253 programmable interval timer lets you program timeouts. For your programs, the ARC-PC has sockets for 8K-byte PROMs and 2K-byte RAMs. ARC-PC supports up to 255 nodes per network segment while running at 2.5 megabits.

In quantity, the ARC-PC costs $495. Contact Standard Microsystems Corp., 35 Marcus Blvd., Hauppauge, NY 11788, (516) 273-3100.

Circle 687 on inquiry card.

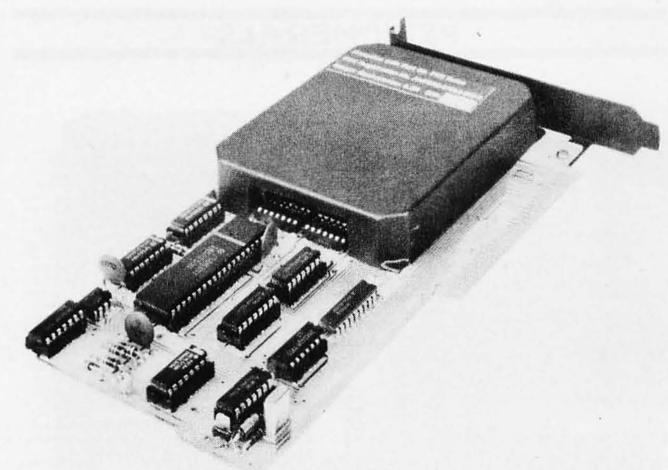


Transmit Two Terminals on One Line

The Model 2X212 Modemplexer, a two-channel statistical multiplexer and modem in a single package, is manufactured by Omnitec Data Inc. This 212A- and CCITT V24-compatible, full-duplex 1200-bps device can transmit data from two remote terminals on a single line, reducing telephone expense and network hardware overhead. Salient features include auto-answer/dial, automatic redial, and automatic selection of appropriate dialing modes. AT & T-licensed and FCC-approved, this unit also provides speed dialing, up to 10 stored numbers, continuous memory, dynamic buffering of up to 3000 characters for both its RS-232C ports, flow control, user-programmable disconnect code, and selectable parity.

The Model 2X212 Modemplexer costs $995. For more information, contact Omnitec Data Inc., 2405 South 20th St., Phoenix, AZ 85034, (800) 528-8423; in Arizona, (602) 258-8244.

Circle 688 on inquiry card.



300-bps Modem Mounts in IBM

Avcom's 300-bps PM-300 originate/answer modem mounts inside the IBM Personal Computer. An auto-answer function lets you select the number of rings before pick up. This modem will dial out with a Touch-Tone or rotary pulse in any combination. The PM-300 does not require an RS-232C card or connectors.

The PC-300 is compatible with Bell-103 standards and with Avcom's Compac and other IBM communications software. Compac is a videotex program that supports asynchronous communications. It provides automatic log-on and file download and upload capabilities under error-correcting protocol. Data received can be entered into a disk file or buffer and displayed, printed, or transmitted.

The PC-300 with Compac costs $249.95. The software alone is $69.95. Details are available from Avcom Inc., POB 29153, Columbus, OH 43229, (614) 882-8176.

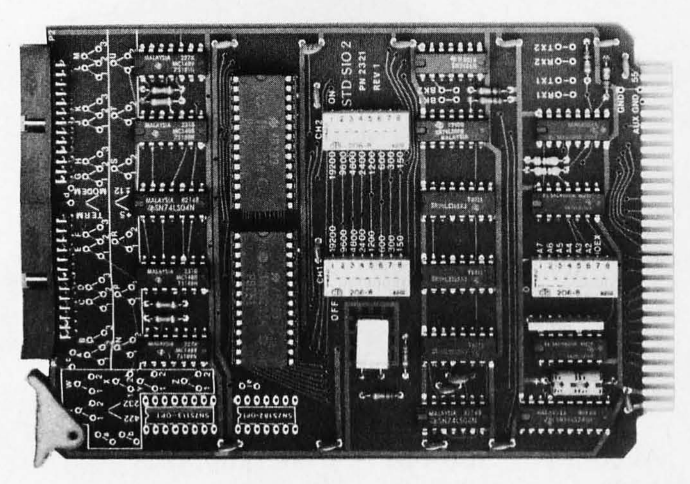
Circle 689 on inquiry card.

Network Driver Hybrid

The Zenith LAND (Local Area Network Driver) Hybrid is a highly reliable interface for such local-area networks as Datapoint's Arcnet. Standard features include a 20 single inline pin configuration, −5 or −12-volt drive, noise immunity and filtering for interference-free data travel for up to 2000 feet of coaxial cable, and a physical layer implementation for interfacing with most network technologies. Zenith offers design and production capabilities to tailor or customize LAND to individual specifications. LAND is available with a straight lead frame or with a right-angle lead frame. For more information, contact Zenith CRT & Components Operations, 1000 Milwaukee Ave., Glenview, IL 60025, (312) 391-7733.

Circle 690 on inquiry card.

PERIPHERALS



Independent Serial Channels

Both channels on the STD SIO-2 RS-232C serial interface board have independent switch-selectable data rates so that you can change transmission speeds without reprogramming the board or modifying system software. These channels offer fully buffered asynchronous operation at speeds ranging from 150 to 19,200 bps. Polled or interrupt modes, terminal or modem-type connection, and switch-selectable board addressing with I/O expansion bit are standard.

An RS-422A channel is optional. The STD SIO-2 costs $185 (two to nine units). Contact Forethought Products, 87070 Dukhobar Rd., Eugene, OR 97402, (503) 484-8575.

Circle 691 on inquiry card.

Tektronix Emulation for the Esprit III

The E-III Graphics Controller gives the Esprit III terminal full Tektronix 4010 emulation capabilities. Tektronix Plot 10 software-compatible, the E-III offers two alphanumeric modes: 24 by 80 or 35 by 73. Both modes can be activated from the keyboard or from the host computer. Other features include automatic vector drawing for creating bar charts, pie diagrams, and histograms.

The E-III Graphics Controller costs $625. It's available factory-direct from ISM Inc., Jackson Place South, Suite 6, 932 Hungerford Dr., Rockville, MD 20850, (301) 279-5775.

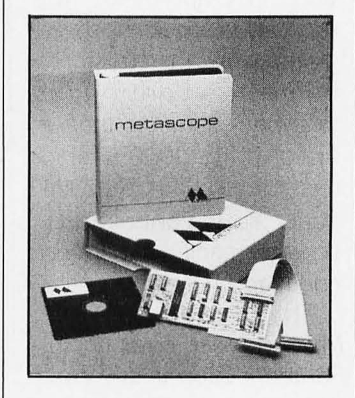
Circle 692 on inquiry card.

Host-Independent In-circuit Emulators

Real-time, transparent emulation of 8086, 8088, and 80186 microprocessors is available through Microcosm's M(x) family of host-independent in-circuit emulators. The M(x) line of emulators consists of an Emulation Module that connects to a Probe Module containing target-system interface circuitry. These emulators communicate with a host system, such as the IBM PC, through a standard RS-232C serial interface and host-specific software. System hardware includes trigger recognition, event recognizers (i.e., processor address, processor data and status, and logic module signals), user-selectable emulation clock, and 8K bytes of parity-protected RAMs. Programmable wait states, three trace modes, diagnostics, and a software interface with menus, high-level command language, and utilities are standard.

Options include memory expansion and communication and logic modules. Complete specifications are available from Microcosm Inc., 1679 Enterprise Plaza, POB 624, Hillsboro, OR 97123, (503) 648-6500.

Circle 693 on inquiry card.



Data Line Monitor

Metascope, a high-performance data line monitor, can display and store data in asynchronous or bit- and byte-oriented synchronous formats at speeds ranging from 110 to 19,200 bps. This hardware/software combination has a pattern-match trigger with pre- and post-trigger capabilities. Data capture of up to 4K bytes with floppy-disk storage and retrieval is possible, and a programmable host-emulation mode allows the Apple to function as a communications controller capable of generating polling sequences with reply. Metascope will generate synchronous clock signals in the host-emulation mode, eliminating the need for modem emulators. Half- and full-duplex displays and ASCII, EBCDIC, and hexadecimal display formats comprise its other abilities.

Metascope works with Apple and Franklin computers. With documentation and software, it costs $895. Contact Metatek Inc., 12525 Hummingbird St. NW, POB 33129, Minneapolis, MN 55433, (612) 571-7319.

Circle 694 on inquiry card.

Physics Lab Interfaces

Cross Educational Software has introduced physics lab interfaces for classroom experiments. The interfaces, Heat, Light, and Sound, are designed for the Apple. They come with a kit of parts that connect to the Apple game port, a disk for calibration, and documentation for several experiments. Each program costs $60.

Light experiments include timing a pendulum, measuring the acceleration of gravity, measuring light intensity, and the efficiency of a light bulb. Four phototransistors are provided. Graphing temperature versus time, thermal radiation, cooling curves, and specific heat make up the Heat experiments. Heat comes with four thermistors. Sound experiments involve sound intensity, simulated oscilloscope, and Fourier spectrum analyzer. A speaker, microphone, potentiometer, transistors, and a capacitor are provided.

For more information, contact Cross Educational Software, POB 1536, Ruston, LA 71270, (318) 255-8921.

Circle 695 on inquiry card.

IBM Color Graphics System

The Cono#Graph color graphics system for the IBM PC is made up of the Cono#Graph Adapter, the Cono#Gen graphics-processing module, and Cono-Lib software. The Adapter substitutes for the IBM graphics card and provides 256 colors from a palette of 16. It supports resolutions of 320 and 640 by 200; the alphanumeric modes are 80 or 40 by 25. It comes with 128K bytes of graphics memory and IBM-compatible character and graphics modes. As many as four graphics pages can be achieved, depending upon display resolution. Each page may be selected for display and, while one is displayed, the others may be modified. The Cono#Color Adapter has a light-pen interface capable of resolving ±1 pixel and an interface to the Cono#Gen graphics processor.

Featuring a dedicated Motorola 6809 processor, Cono#Gen has high-speed hardware generators for vectors, circles, ellipses, and conic curves at speeds up to 800,000 pixels per second. It provides a 2K by 2K addressable area, rectangle fill, and line texturing. It's supplied with Cono-Lib, an extensive library of subroutines for scaling, rotation, fill, image creation, labeling, and recall. Cono-Lib runs under PC-DOS and works with Pascal, BASIC, C, FORTRAN, or assembly language.

The complete Cono#Graph system fills a single IBM expansion slot. The Cono#Color Adapter is $895. Cono#Gen costs $745, including the software. The software alone is $125. Full details are available from Conographic Corp., 2268 Golden Circle, Newport Beach, CA 92660, (714) 650-2666.

Circle 696 on inquiry card.

Add-ons Enhance Hero's Image

Perbotics markets three add-ons for Heath's Hero I robot: an 8K-byte RAM/communications board, a 44K-byte RAM/communications board, and a software package. The 8K-byte RAM comes with 20 sockets for individualized expansion, while the 44K board incorporates an RS-232C-compatible port that lets the Hero communicate with a computer. Perbotics' cassette-based software provides load and dump routines for downloading and storing programs through the RS-232C port and a memory verification routine.

The 8K- and 44K-byte boards cost $395 and $795, respectively. The software is $49. Order these products factory-direct from Perbotics, 211 Costa Mesa St., Costa Mesa, CA 92627, (714) 845-9294.

Circle 697 on inquiry card.

CP/M Processor Works with TI 99/4A

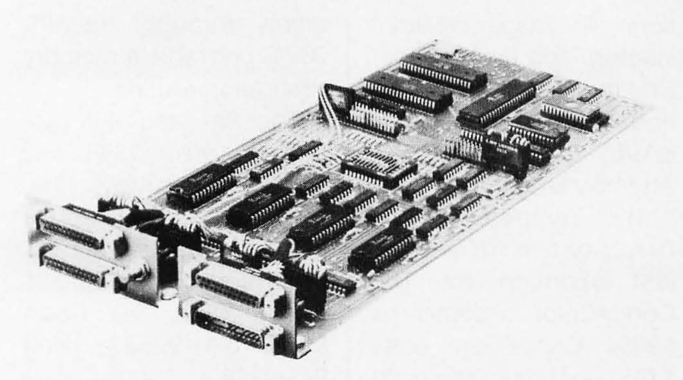
The Morning Star CP/M Processor gives TI 99/4A owners the ability to run CP/M programs. This device contains a 5-MHz 8085 microprocessor, 64K bytes of RAM, and an 8K-byte operating system. Connections are made by slipping the CP/M Processor into the TI 99/4A's expansion box.

The CP/M Processor costs $595. For full details, contact Morning Star Software, 4325 109th Ave., Beaverton, OR 97005, (800) 824-2412; in Oregon, (503) 646-4695.

Circle 698 on inquiry card.

Device Guards Entry to Computers

Lineguard 3000 from Western Datacom intercepts all incoming computer access calls and requests identification codes from callers. Lineguard searches its memory to verify code numbers and denies access to the computer if its search proves fruitless. If the verification is completed, Lineguard calls



back and connects the caller to the computer. Communication is through the caller's display. Lineguard scans two incoming lines and is compatible with asynchronous dial-up modems and protocols. Failed entry attempts are permanently recorded for evaluation.

Lineguard costs $945. For more information, contact Western Datacom Co., 5083 Market St., Youngstown, OH 44512, (216) 788-6583.

Circle 700 on inquiry card.



Weather Sensing Package

HAWS, Home Automatic Weather Station, is designed for the Commodore 64 and VIC-20. HAWS has an external sensing device that lets you monitor weather conditions inside or outside your home. You can interact and analyze input for predicting changing weather conditions and rating your forecasting abilities.

HAWS costs $199.95, complete with sensor, cassette or floppy-disk software, connecting cable, and manual. Address dealer and customer inquiries to Vaisala Inc., Consumer Products, 2 Tower Office Park, Woburn, MA 01801, (617) 933-4500.

Circle 701 on inquiry card.

SOFTWARE

Leading Edge of IBM PC Word Processing

The recently introduced Leading Edge Word Processor for the IBM Personal Computer is said to be easy to learn. Priced at less than $300, this word processor lets you print your documents in color. Standard editing features include single-keystroke character or block insert, delete by character or block, delete recall, and search and replace. You can set tab stops, margins, spacing, page length, and pitch and place format lines anywhere in a document. A split-screen feature lets you review more than one document on the same screen.

Also standard are the ability to insert date or time in text, a change-case mode that permits altering a character from uppercase to lowercase or vice versa without retyping, transposition of characters for reversing common typos, and the ability to jump to any page in a document. One built-in feature lets you move the cursor by character to the beginning or end of the document; you can also move the cursor by previous or next word, line, sentence, screen, or page.

Text attributes include indent, reverse indent, center column, decimal tabs, and word wrap. Boldface, double-width characters, strike-through, super- and subscripts, underline, double underline, a variety of character fonts, and justified type are among the print features available. You can print a text screen, sections of a text screen, or an entire document.

For complete details, contact Leading Edge Products Inc., 21 Highland Circle, Needham Heights, MA 02194, (800) 343-3436; in Massachusetss, (617) 449-4655.

Circle 702 on inquiry card.

Modula-2 for IBM PC

Modula-2 for the IBM Personal Computer is available from Volition Systems. This version uses standard software modules and separate compilation with automatic control. It comes with a comprehensive module library, a compiler, and tutorials. Modula-2 features low-level machine access, real-time control, concurrent processes, and type-secure separate compilation with automatic version control. Highlights include communication between the compiler and editor, which reduces development time, dynamically linked modules, and a user-friendly interface and prompts. Real-number and transcendental mathematical support are provided by the 8087 numerics processor, and interrupt-handling is fully supported. The Modula library provides console I/O, random-access files, disk-directory operations, format conversion, strings, decimal arithmetic, storage management, program execution, and process scheduling. Programs written in Volition Systems' Modula-2 are

said to be directly portable from the IBM PC environment to the Apple.

Volition currently supplies Modula-2 for the Apple II under Apple Pascal, the Apple III running SOS, and as part of a complete software system for computers based on 8080/Z80 and 68000 microprocessors. The complete Modula-2 system for the IBM PC includes Pascal and Modula-2 compilers, a module library, an advanced system editor, a p-NIX command shell that provides a Unix-like programming environment, and a set of utility programs. It costs $595; educational, retailer, and distributor discounts are available. Contact Volition Systems, POB 1236, Del Mar, CA 92014, (619) 481-2286.

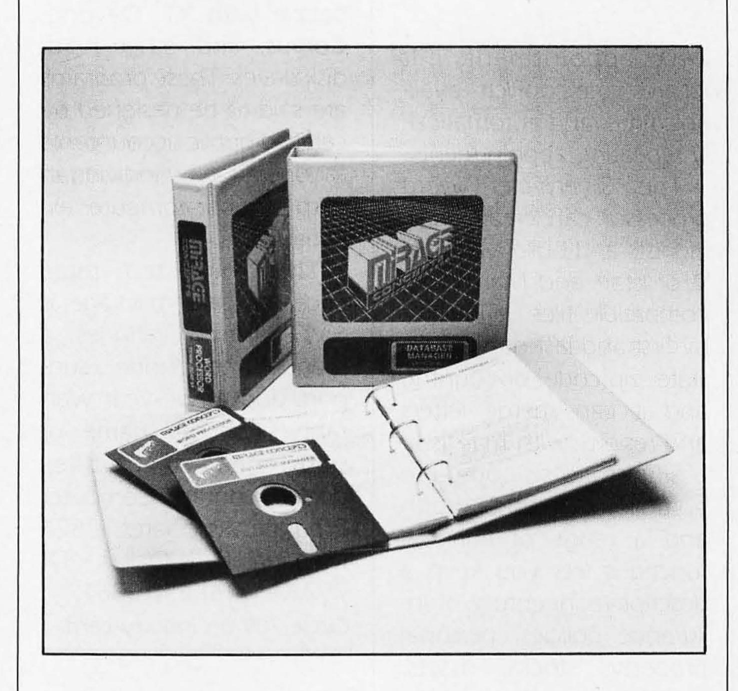
Circle 703 on inquiry card.

Health Check Offers Advice

A computerized health-risk-appraisal program designed to make individuals more aware of the difference various health risks can make in their lives is available from the Rhode Island Department of Health. The Wellness Check is suitable for use in hospitals, state and local health departments, companies, schools, and health maintenance organizations. It consists of a questionnaire covering a broad range of lifestyle topics. Responses to the questionnaire are fed into a computer, and within a few minutes an individualized printout assessing the respondent's health is produced. Advice is offered on how to reduce health risks outlined in the report.

Wellness Check is written in BASIC and runs on Apple II Plus/IIe, IBM PC and PC XT, and Radio Shack TRS-80 Model II, 12, and 16 computers. It costs $250, which includes complementary educational materials for adults and teenagers. It can be ordered from the Office of Health Promotion, Rhode Island Department of Health, 75 Davis St., Providence, RI 02908, (401) 277-6957.

Circle 704 on inquiry card.



Word Processor and Database Manager for Commodore 64

Mirage Concepts is marketing a word processor and a database manager for the Commodore 64. The database manager will store, search, sort, retrieve, display, calculate, and print reports, lists, and mailing labels. It features free-form design and input, the ability to sort on any field or level, calculated fields, and system parameters large enough for most file functions. It can accommodate 65,535 records per file, 2000 characters and 200 fields per record, and 250 characters per field.

The word processor produces an 80-column display without additional hardware. It has true word-wrap, more than 70 single-stroke commands, search and replace operations, block functions, macro instructions that permit it to work with a variety of printers, and printed page, line, and character counters. Text can be formatted onscreen exactly as it is to appear in hard copy. A high-resolution monitor is recommended but not required.

Both programs are written in machine language and interface with each other. The suggested list price for each program is $99, including documentation with tutorials. For additional information, contact Mirage Concepts Inc., Number 106, 2519 West Shaw, Fresno, CA 93711, (202) 227-8369.

Circle 705 on inquiry card.

CP/M Recovery Program

Lion Micro Systems' CP/M Recovery eliminates data and text loss in computer memory due to system crashes, program or operator errors, failure to back up, and disk failures or unexpected full-disk conditions. This user-friendly program lets you recover memory, conduct editing on data within memory (including control characters), and save data to a disk file.

CP/M Recovery works with single- or multiuser systems. It costs $99 and is available from Lion Micro Systems / In-Sync Systems Inc., Suite 501, 1900 Pacific Ave., Dallas, TX 75201, (214) 760-9120.

Circle 706 on inquiry card.

Spelling Teacher

A program called Spelling Teacher for the NEC PC8000 can be ordered directly from Computech. For each session, the program confronts your child

with 25 spelling problems. Misspelled words are the first words presented during the next session. The program contains a password security system and four word files, each representing a different skill level. Word files can be changed and modified. Program options include the ability to display a bar chart representing the scores of the last 10 sessions.

The Spelling Teacher requires one disk drive, 32K bytes of memory, and a monochrome or color display. It costs $39.95 and can be purchased from Computech, POB 7000-309, Redondo Beach, CA 90277.

Circle 707 on inquiry card.



Home Management Series

A home management system from Douthett Enterprises, Silversoft comprises budget, calendar, word processing, and personal portfolio programs. Each program runs on 128K-byte IBM Personal Computers and offers self-documenting prompts and error messages. The Silverbudget program is a double-entry accounting system with 240 categories, unlimited transactions, and check reconciliation. It can handle multiple checkbooks and features a flexible search function and transaction calendar. Silvercalendar provides multidimensional scheduling of 240 appointments. It locates time conflicts, available time, and automatically repeating appointments.

The Silverwriter word processor can create mailing lists and build Micropro Wordstar- and Mailmerge-compatible files. It indexes by first and last name, city, state, zip code, or country, and it can merge letters and reports with mail lists.

Silverfolio's complete portfolio of personal worth and a range of financial functions lets you keep a descriptive inventory of insurance policies, personal property, stocks, assets, real estate, and valuables. In addition, it can produce net-worth statements and amortization schedules.

Each program works with floppy- or hard-disk drives and requires a printer and CP/M-86. Contact Douthett Enterprises Inc., Suite 1, 906 North Main, Wichita, KS 67203, (316) 262-1040.

Circle 708 on inquiry card.

Accounting for the IBM PC

Certiflex Business Accounting Software for the IBM Personal Computer and PC XT is written in Microsoft BASIC and operates under PC-DOS. Available packages include general ledger, accounts payable with check writing, accounts receivable with billing, inventory control and management, payroll with check writing, and fixed assets/depreciation. All Certiflex packages are menu-driven and compatible with XT, Davong, Corvus, and other hard-disk drives. These programs are said to be designed by certified public accountants for operation by individuals with no prior computer experience.

The suggested retail price for each package is $549, which includes a manual, telephone support, and a two-year warranty. For the name of your nearest Certiflex dealer, contact Computer Program Associates, 2526 Manana Dr., Dallas, TX 75220, (214) 350-2361.

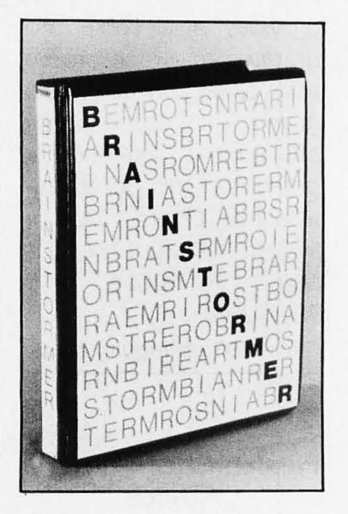
Circle 709 on inquiry card.

Matchpoint for MS-DOS and CP/M-86

American Compusoft is marketing a program that lets MS-DOS users run CP/M-86 software. Matchpoint/86 features a File Commingle mode that lets you call for information stored in CP/M-86 format and use it while operating MS-DOS, and vice versa, which makes it possible to run two operating systems simultaneously. When your program is finished, your computer automatically returns to MS-DOS.

Matchpoint/86 does not require hardware alterations or conversion equipment because it resides in 8K bytes of RAM. It works with floppy or hard disks. The suggested retail price is $99. For more information, contact American Compusoft, 23113 Plaza Pointe Dr., Laguna Hills, CA 92653, (800) 235-7049; in California, (800) 235-2394 or (714) 472-8186.

Circle 710 on inquiry card.



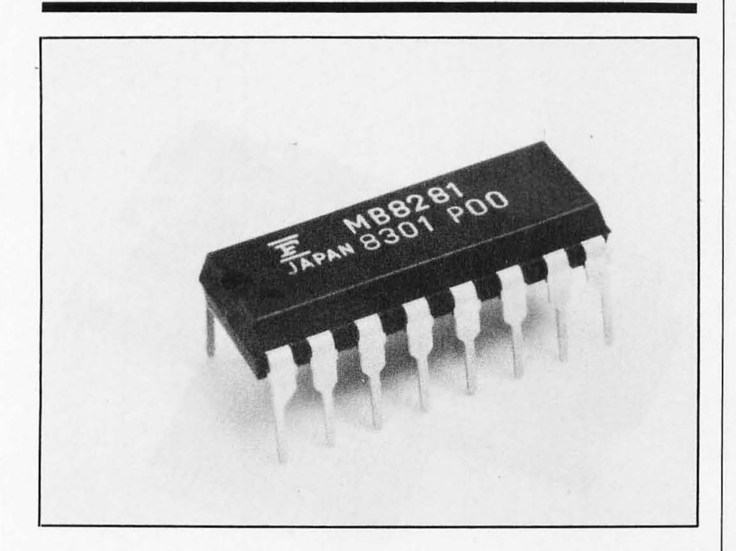
Brainstorm Your Way Through Problems

Soft Path Systems' Brainstormer helps you generate potential solutions to complex problems. Potential applications include discovering new products, targeting markets, and exploring organizational problems. Brainstormer works by building a description of a problem in terms of themes and variations that affect its solution. You refine the process by controlling the occurrence of particular themes and variations until a sufficient amount of potential strategies are produced.

Brainstormer requires MBASIC, two single-density single-sided 5¼-inch disk drives, and 48K bytes of memory. It's available for the Radio Shack TRS-80 Model I/III and IV and CP/M computers with 80-column screens, such as the Apple II, Osborne I, and Kaypro II. Available for $50 directly from Soft Path Systems, Cheshire House, 105 North Adams, Eugene, OR 97402, (503) 342-3439.

Circle 711 on inquiry card.

CHIPS



CMOS ROM and Static Column RAM

Fujitsu Microelectronics' MB83256 is a 256K-bit CMOS static ROM organized as 32,768 eight-bit words. It offers twice the memory capacity of a 128K-bit ROM in a JEDEC-compatible 28-pin DIP. Key specifications include 250-ns access time, active power dissipation to less than 83 mW, TTL compatibility, single 5-volt supply, and fully static operation. The MB83256 is designed for large memory capacity and high-speed, low-power environments, such as character generation and large volume firmware storage.

Also available from Fujitsu is the MB8281 Static Column Dynamic RAM. Offering low power consumption and high-density capabilities, this DRAM features a 64K- by 1-bit organization, a column-address access time of 55 ns, a 60-ns cycle time, a chip-select access time of 20 ns, and 120-ns row-access strobe time. Power consumption is 28 mW (standby) and 440 mW (static mode).

For full details, contact your local Fujitsu Microelectronics sales office. Fujitsu Microelectronics, 3320 Scott Blvd., Santa Clara, CA 95070, (800) 553-2000; in California, (408) 866-5600.

Circle 712 on inquiry card.

16-Bit CMOS Microprocessor

Harris Semiconductor CMOS Digital Products Division has announced a high-performance 16-bit CMOS microprocessor, the 80C86. The 80C86 is said to be a completely compatible CMOS alternative to the Intel HMOS 8086. Featuring a static design that allows it to be operated from DC to 5 MHz, the 80C86 permits single-step debugging, a standby power supply current of 500 microamperes over the full operating temperature and voltage ranges, and an operating current of 10 mA/MHz. For maximum power reduction, the 80C86's system clock can be stopped with all power requirements falling to the standby level, 500 μA. The 80C86 comes in industry-standard 40-pin 0.6-inch center ceramic and plastic DIP packages for commercial, industrial, and military markets. It's available with a 5-MHz operating frequency. An 8-MHz version will be offered.

A complete family of support peripherals is available for the 80C86, including a programmable interval timer and a priority interrupt controller. In 100-unit lots, pricing begins at $31.25 each for the plastic package. Contact Harris Corp., Semiconductor Sector, POB 883, Melbourne, FL 32901.

Circle 713 on inquiry card.

MOS ROM Features Page Mode Function

Signetics Corporation has introduced a 64K-byte MOS ROM that doubles the effective memory capacity in video game cartridges. The 26S64's page mode incorporates an address-decoding technique that permits automatic selection of two 4K-byte memory banks, which is billed as being twice the firmware capacity of industry-standard 32K-byte ROMs. Its bank-select addresses trigger a latch that functionally serves as the thirteenth address bit for the 8K-byte memory. (The bank-select address locations must be programmed as no-ops.) Other features include high noise immunity, 550 mW power dissipation (maximum), and a 450-ns access time.

The 26S64 is made with N-channel silicon gate MOS technology using 3-micron design rules. It is TTL-compatible and requires a single +5-volt power supply. It comes in a 24-pin plastic DIP rated for 0° to 70° temperature range operation. In commercial quantities, it costs $3.85. Contact the MOS ROM Product Marketing Manager, Signetics Corp., Mail Bin 1437, 811 East Arques Ave., POB 3409, Sunnyvale, CA 94088, (408) 746-1755.

Circle 714 on inquiry card.

DUARTs Have Independent Channels

Motorola is marketing a pair of Dual Universal Asynchronous Receivers/Transmitters (DUARTs), the MC68681 and the 2681. These devices provide two

independent full-duplex asynchronous receiver/transmitter channels, quadruple-buffered receivers, and multipurpose I/O ports. They can be used in polled or interrupt-driven systems, and each device provides flow-control capabilities to disable a remote transmitter when the receiving unit's buffer is full. Each receiver/transmitter can have independent operating speeds, selected from one of 18 fixed data rates ranging from 50 to 38,400 bps, derived from an internal data-rate generator, a 16X clock derived from a 16-bit programmable multifunction counter/timer, or an external 1X or 16X clock. Data transfers can take place at up to 1 million bps for a 1X clock or up to 125,000 bps for a 16X clock. Other features include local and remote loopback modes and an automatic wake-up mode that permits blocks of data to be sent to targeted slave processors among a group of slaves in multidrop or multiprocessor systems.

The MC68681 works with Motorola's M68000 family, while the 2681 interfaces with non-M68000 family microprocessors. Both have 8-bit output ports; however, the MC68681 has a 6-bit input port and the 2681 offers a 7-bit port.

In quantities of 100, these DUARTs cost $20.45 in 40-pin ceramic packages. Plastic packaging is also offered. A 28-pin version of the 2681 with a 1-bit input port and a 2-bit output port, called the 2682, is also available. For further information, contact Motorola Inc., MOS Microprocessor Division, 3501 Ed Bluestein Blvd., Austin, TX 78721.

Circle 715 on inquiry card.

Cache and Memory Management Standard on Z80,000

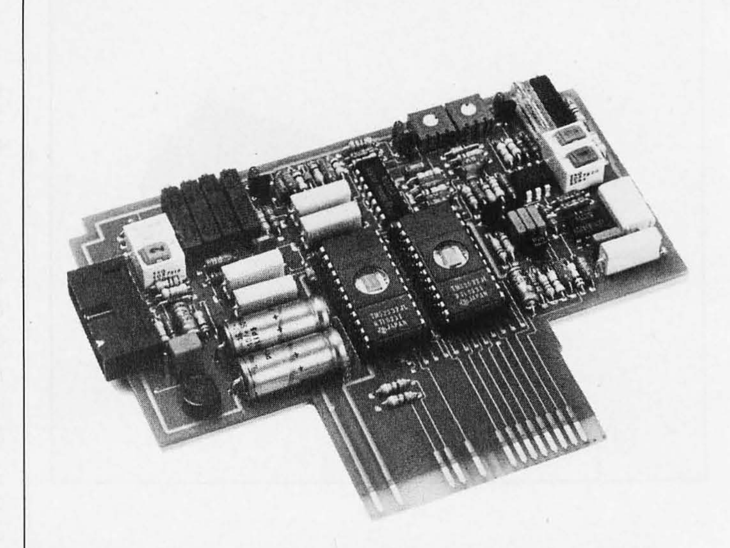
Zilog's 32-bit Z80,000 offers an on-chip cache, memory management, and the ability to execute up to 5 million instructions per second. Designed for clock speeds ranging from 10 to 25 MHz, this chip features full 32-bit architecture and implementation, a complete 32-bit instruction set, 32-bit internal and external data paths, and full support for 32-bit data types.

Fully compatible with the Z8000 family, the Z80,000 comes with 4 gigabytes of directly addressable memory and three selectable address modes: 32-bit linear, 32-bit segmented, and 16-bit compact. Data types supported include bit, bit field, logical value, signed integer, and string. In the compact mode, addresses are 16 bits. All addresses in the linear mode are 32 bits, while in the segmented mode the addresses are divided into either a 15-bit segment within a 16-bit segment offset or a 7-bit segment with a 24-bit segment offset. Other specifications include sixteen 32-bit general-purpose registers, two arithmetic and logic units, privileged instruction traps and memory-protection-violation traps, two main operating modes supported by separate stacks, and vectored, nonvectored, and nonmaskable interrupts.

The Z80,000, an NMOS chip with 2-micron geometries, is housed in a 68-pin JEDEC B leaderless package. In 1000-unit lots, it costs $150. Complete specifications are available from Zilog, 1315 Campbell Ave., Campbell, CA 95008, (408) 370-8000.

Circle 716 on inquiry card.

FOREIGN



Interface Puts Commodore on Air

The Com-In 64 interface turns your Commodore 64 into a radio-communications terminal. Available from Computer World Holland, this interface gives the Commodore baudot, Morse code, ASCII, slow-scan television, half-duplex, program transmit, and word-processing capabilities. Com-In 64 comes with a ROM-based machine-language program that recognizes more than 60 commands, provides a full-screen editor, and supports hard-copy printout and disk or cassette saves.

Com-In 64 features ASCII program receive and transmit, a built-in AFSK (audio-frequency shift keying) generator, seven 80-character message buffers with display, print, and write options, a tone generator, an auto transmit/receive switch for telephone/telegraph lines, and four CW (continuous wave) identification lines. The modem is a 300-bps half-duplex with automatic Bell/CCITT selection.

The Com-In 64 costs $179, including ROM-based software, required hardware, power supply, an English-language user manual, schematic diagram, and two program listings. Contact Computer World Holland, Hilvert-

sweg 99, 1214 JB Hilversum, Holland; tel: 31-3512633; Telex: 43776 INCO NL.
Circle 717 on inquiry card.

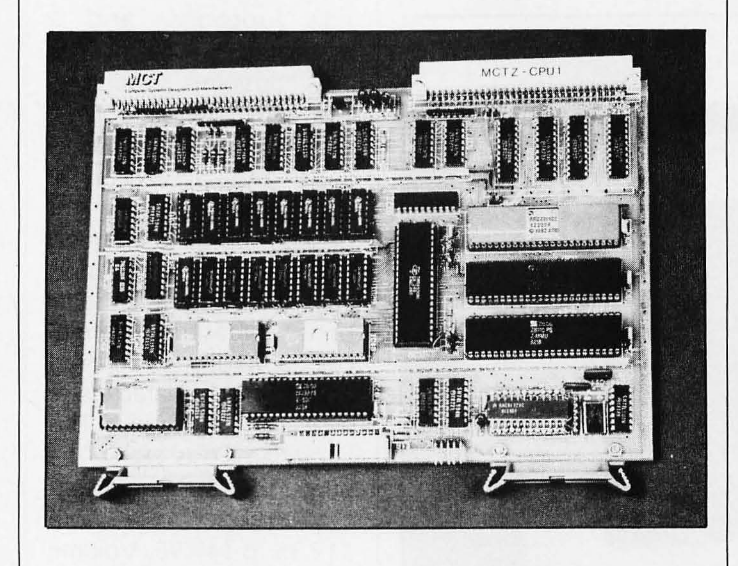
Software for School Administrators

Vertical Software Systems markets a series of applications packages designed for school board/district administrators. ST/VS is a transportation-management program featuring bus-load simulation and student-data and fleet-data maintenance. MC/VS is a media-center management program that includes provisions for media catalog generation and material-lending and booking control. AC/VS, a fixed-asset management and control system, is also available.

These programs are produced with the C language and are executable under CP/M 2.2, CP/M-86, and MS-DOS. For full details, contact Vertical Software Systems Ltd., 118 Song Meadoway, Willowdale, Ontario, M2H 2T7, Canada, (416) 497-6854.
Circle 718 on inquiry card.

Interactive Query Language Runs on CP/M

The Automated Office has announced the fourth generation of Microtrieve, a high-level interactive query language for CP/M computers, modeled on DEC's Datatrieve. Microtrieve lets inexperienced computer operators extract, sort, and report data from fixed-record-length files created by most application packages or from a text editor. This language accepts English-like commands. For complete information, address inquiries to The Automated Office Pty. Ltd., POB 490, Chatswood, New South Wales 2067, Australia; tel: (02) 411 1892.
Circle 719 on inquiry card.

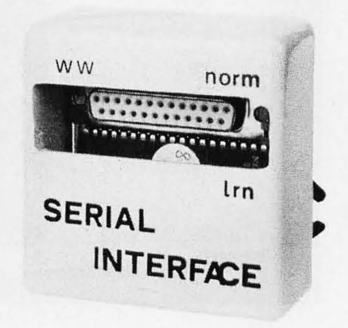


Z8001-based Microcomputer

The MCTZ CPU1 is the first in a series of single-board computers from MMG Consultants Ltd. The CPU1 is targeted at OEMs and systems builders who require a compact computer capable of expansion by means of a 16-bit bus. The CPU1 is based on the double-Europa format and the 4-MHz Z8001 microprocessor. It features a Z8010 MMU, a Z8016 dual-channel DMA controller, a Z8030 synchronous/asynchronous dual-channel serial controller, and the AM9511A chip for floating-point and trigonometric functions. Standard equipment includes 128K bytes of RAM, sockets for 16K bytes of EPROM, facilities for single-step and stop, DIN 41612 type B indirect connectors, and operational software. The CPU1 costs £2050. For complete specifications, contact MMG Consultants, 19. St. Andrews Rd., Great Malvern, Worcester, WR14 3PR, England; tel: Malvern (06845) 63555.
Circle 720 on inquiry card.

Apple Boards

U-Microcomputers recently introduced four Applebus cards: U-Print16, U-Talk, U-4Disc, and U-Cent. The U-Print16 provides parallel or serial interfacing for connecting printers. It has a 16K-byte buffer and can print graphics directly to Epson and Apple dot-matrix printers. The U-Talk speech synthesizer uses the National Semiconductor Digitalker. A disk controller, the U-4Disc allows up to four drives to be connected to the Apple. U-Cent is a Centronics-type parallel printer interface. For further information, contact U-Microcomputers Ltd., Winstanley Industrial Estate, Long Lane, Warrington, Cheshire WA2 8PR, England; tel: 0925 54117; Telex: 629279 U-MICRO G.
Circle 721 on inquiry card.



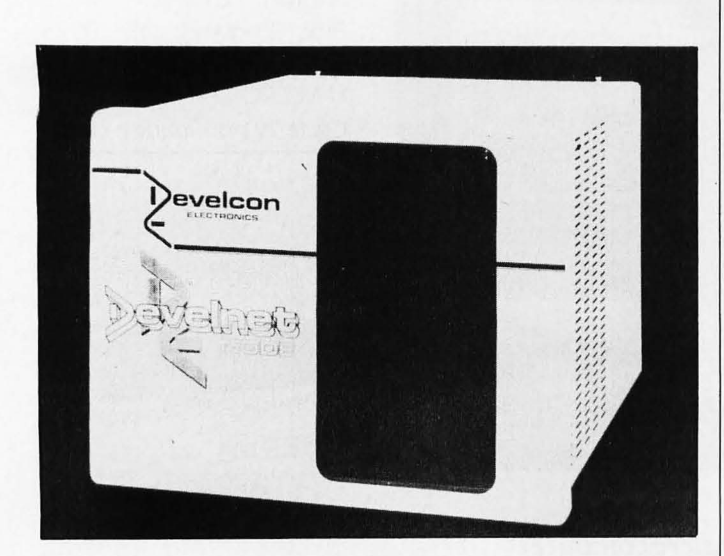
Serial Interface Connects Parallel Printers

The Model 8200 serial interface from Mikrocomputertechnik lets you connect most Centronics-type parallel printers to computers with RS-232C output. In its learning mode, the Model 8200 automatically detects a serial computer's data rates, number of data and stop bits, and parity and adapts itself to the various pin-outs. After installation, which can be repeated whenever parameters change, all parameters are permanently stored in EEROM. Up to 15 code changes can be selected in a simple dialogue. The following parameters are automatically detected

by this interface: 7 or 8 data bits; even, odd, or no parity; 1, 1.5, and 2 stop bits; and 150, 300, 600, 1200, 2400, 4800, and 9600 bps.

The Model 8200 serial interface costs $125; volume discounts are available. Dealer inquiries are invited. Contact Mikrocomputertechnik, Winchenbachstr. 3A, D-5600 Wuppertal 2, West Germany; tel: 0202 51044.

Circle 722 on inquiry card.



Network Switching Node

Develnet is a network of switching nodes providing local-network and distributed switching capabilities. Each node supports up to 248 data lines with a throughput of 24 million bps. Up to 64 Develnets can be interconnected in a hierarchical network. Asynchronous and synchronous speeds to 19,200 bps are supported by means of twisted-pair wire or local RS-232C cables to the nodes. Other features include intelligent line cards and data sets, redundant backup hardware, integral statistical multiplexers, protocol converters, gateways to Ethernet and X.25 networks, and an English-like command language for network configuration. Further details are available from Develcon Electronics Ltd., 856 51st St. E, Saskatoon, Saskatchewan S7K 5C7, Canada, (306) 664-3777.

Circle 723 on inquiry card.

SYSTEMS

Briefcase-size Workslate

Convergent Technologies' Workslate combines portable computing power, information storage, and business programs in a package small enough to fit into a briefcase. Built around an 8-bit CMOS microprocessor, the Workslate comes with 64K bytes of ROM, 16K bytes of RAM, an integral microcassette recorder, a 46-character by 16-line LCD display, an internal 300-bps modem with auto-dial and auto-answer, and a 9600-bps serial interface port. It's powered by four AA alkaline cells or an AC recharger. Standard features include an internal clock, edit functions, and a calculator.

A business worksheet with integrated date, time, and communications functions and a variety of microcassette tapes for general business, vertical market, and personal applications are offered. A serial printer featuring multicolors, 90-degree printing, and formed characters is available as well. The Workslate costs $895. The printer is $250, and software prices range from $19.95 to $49.95. Volume shipments begin in January. For more information, contact Convergent Technologies, 795 Kifer Rd., Sunnyvale, CA 94086, (408) 732-2310.

Circle 724 on inquiry card.

Honeywell 6/20 Supports Four Users

Honeywell's Microsystem 6/20 supports up to four users, targeting it directly at the departmental office system and small-business market. The basic 6/20 contains a 16-bit Honeywell Micro 6 processor, up to 1 megabyte of main memory, 650K bytes of 5¼-inch floppy-disk storage, a 40-megabyte hard-disk featuring 20 megabytes of removable media, an open slot, and five RS-422A ports that are adaptable to RS-232C devices. The GCOS 6 MOD 400 operating system, used in Honeywell 16- and 32-bit DPS 6 computers, is standard. GCOS 6 MOD 400 is menu-driven and supports transaction processing, data entry, office automation, terminal emulation, program development, and communications software.

The 6/20's communications features let it serve as an endpoint for several workstations in larger Honeywell or IBM information-processing networks, such as those using DSA and SNA protocols. In addition to these abilities, the 6/20 can provide electronic mail, BSC and pre-DSA communications, and teletype emulation.

A number of office-automation and data-entry packages to integrate system and applications software with the 6/20 are available. Other options include three dot-matrix and two letter-quality printers, a dual-line asynchronous/synchronous communications controller, and a second 40-megabyte disk. The basic 6/20 costs $17,000. Workstations configurable for the system start at $795. The printers begin at $1195. For more information, contact Honeywell Inc., U.S. Marketing and Services Group, 200 Smith St., Waltham, MA 02154, (617) 895-3658.

Circle 725 on inquiry card.

BBC Computer Available in U.S.

The Acorn BBC computer is now available in

the United States through Fourth Dimension. This 2-MHz 6502-based microcomputer comes with 32K bytes of RAM, 32K bytes of ROM, a 73-key QWERTY keyboard with 10 user-definable function keys, a three-voice music synthesizer with full sound envelope, and a speech-generation system. Rear-panel connections are provided for UHF out, video out, RGB monitor, audiocassette, and a local-area network. The built-in RS-423A serial interface, an RS-232C interface enhanced for speed and distance, has software-selectable data rates ranging from 75 to 19,200 bps. A floppy-disk interface and four 12-bit analog input channels are standard.

NTSC television output, RGB video output for color monitors, and monochrome monitors compose the video-display options. Among the display modes available are 40 by 22 Teletext, 160 by 200 four- or 16-color graphics and 20 by 25 text, and 640 by 200 two-color graphics and 80 by 25 text.

A 16K-byte BASIC interpreter in ROM comes with the BBC. This interpreter has a 6502 assembler that permits BASIC statements to be mixed with 6502 assembly language and such extensions as local variables, subroutines that pass parameters, and recursion. Also in ROM is View, a 16K-byte word processor. View provides global and selective formatting; search, change, and replace facilities; adjustable tab stops; and automatic page numbering.

Optional expansion capabilities include a second 6502 or Z80B processor with 64K bytes of RAM and a National Semiconductor 16032 chip. The Acorn BBC computer begins at $995. Dealer inquiries are invited. For further details, contact Fourth Dimension Systems, 1101 South Grand Ave., Santa Ana, CA 92705, (714) 835-6202.

Circle 726 on inquiry card.



Group Computer Handles Information Needs

Sykes Datatronics' Genus-GC Group Computer and its complementary software are targeted at the information-handling needs of managers, group or team leaders, and the people they manage. This multiuser, multitasking desktop computer performs traditional data-processing functions, connects to a variety of terminal devices, and allows data from a number of sources to be gathered and interfaced with existing data streams and formats. All data, which is fully secured, can be reformatted to meet individual requirements by means of an optional software "forms" package. This software permits user definition and implementation of a complete information system that includes input, file management, and output processing. Sykes has also developed software that provides basic call-costing accounting functions for up to 2000 lines. Called Telemiser, this program can store more than 50,000 call records.

Some of Genus-GC's technical specifications are 68B09E processing power, 256K bytes of DRAM with parity error correction, real-time clock, PABX-oriented networking abilities, and twin RS-232C ports. Mass storage is provided by a 1-megabyte 8-inch double-sided, double-density floppy-disk drive and a 10- or 15-megabyte 5¼-inch Winchester disk drive. Enhanced with shell procedural capabilities and hierarchical directory structure, the OS9 Unix-like operating system is standard.

An internal modem, two additional RS-232C ports, and terminals, printers, and remote data-communications are among the options offered. Prices for the Genus-GC begin at $9455. Further details are available from Sykes Datatronics Inc., 159 East Main St., Rochester, NY 14604, (716) 325-9000.

Circle 727 on inquiry card.

Large Memory Accompanies Rebel

The Rebel computer from Tarbell Electronics comes with 372K bytes of floppy-disk storage and 19 megabytes of hard-disk memory. The Rebel features 64K bytes of RAM, two RS-232C ports, and a 6-MHz Z80B microprocessor. The Tarbell database system, BASIC, Wordstar, and CP/M 2.2 are supplied with the Rebel.

The Rebel costs $4995, including a cabinet that houses all hardware and the power supply. Complete details are available from Tarbell Electronics, Suite B, 950 Dovlen Pl., Carson City, CA 90746, (213) 538-4251.

Circle 728 on inquiry card.



Micro Processes Data and Words, Has Communications Features

The Stearns Computer is purported to be the first stand-alone desktop computer specifically designed to perform high-quality data and word processing while providing full internal and external communications and networking capabilities. This 16-bit 8086-based system can be configured with as many as four 5¼-inch floppy-disk drives and two 5-, 10-, or 20-megabyte Winchester hard-disk drives. It comes with 128K bytes of parity RAM, time and date clock with battery backup, 16K

bytes of ROM for initialization and self-tests, up to a dozen DMA channels, and four slots for expansion boards. The standard operating system is MS-DOS. The 12-inch display uses a 7220 graphics display controller and provides 26 lines of 80 characters and the 256-character IBM font with an additional user-defined font. Attributes include reverse video, blink, bold, and underline.

Communications capabilities include an RS-232C port operating at speeds ranging from 75 to 19,200 bps, built-in tutorial prompts, disk-file transfer with error recovery, automatic dial-up for host access, user-defined data translation, Teletex, IBM 3270 bisynchronous and IBM 3270 SNA/SDLC protocols, and from two to four asynchronous or synchronous RS-422A channels with operation to 56,000 bps. Optional networking abilities are available through Micronet, which allows up to five intelligent workstations to be linked together. Each workstation is able to use applications software, files, and databases while sharing printers, a common database, and communications with external sources. Stearns is working on an intelligent communication system that will work with Micronet to handle up to 32 workstations.

Color graphics, 15-inch display screens, 128K or 256K bytes of memory, Concurrent CP/M, and a two-channel Winchester-disk controller are some of the options offered. For full details, contact Stearns Computer Systems, 3501 Raleigh Ave. S, Minneapolis, MN 55416, (612) 929-4400.

Circle 729 on inquiry card.

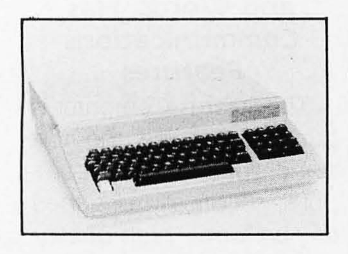


Shirt-pocket Computer

Radio Shack's four-ounce TRS-80 PC-3 pocket computer will slip into your shirt pocket. The PC-3, programmable in BASIC, provides 16 arithmetic and 8 string functions. Strings can be up to seven characters long. The PC-3, which can be used as if it were a direct key-entry calculator, has a 24-character LCD, up to 10 digits of accuracy, 1.4K bytes of memory, two-digit exponents, and multiple statements and arrays. Other features include automatic power-off to save battery life and compatibility with PC-1 programs.

A printer/cassette interface is available as an option. The thermal dot-matrix printer produces 24 characters per line at 1 line per second. The printer/cassette interface costs $119.95. The PC-3 is available for $99.95 at Radio Shack stores and Computer Centers. Radio Shack, 1800 Tandy Center, Fort Worth, TX 76102.

Circle 731 on inquiry card.



CP/M and AppleDOS Combined in One System

The System One from Extra Computer Corporation is a Z80/6502-based computer supporting CP/M 2.2 and AppleDOS. Principal features include 64K bytes of RAM, 8K bytes of system ROM, 16K bytes of user ROM, and seven peripheral slots. Low- and high-resolution graphics, 40- and 80-column display modes, and NTSC and RF modulated video outputs are built in. The keyboard, a standard typewriter-style model, is augmented by an extra numeric keypad for repetitive number entry. System software is made up of Applesoft, Perfect Writer, Perfect Calc, and a games package.

The suggested retail price is $795. For full specifications, contact Extra Computer Corp., 68 Dorman St., San Francisco, CA 94124, (415) 285-0194.

Circle 730 on inquiry card.

MASS STORAGE

18-megabyte Streaming Tape Backup

Davong's stand-alone streaming tape drive backs up any Winchester- or floppy-disk drive used with the IBM Personal Computer. The Davong unit copies 18 megabytes of formatted data onto a single 450-foot ¼-inch tape cartridge. It's supplied with software utilities for initial checkout, copy from disk to tape, and restoring files from tape to disk. The utilities also compare files so that the most current file with the same name is restored, preventing retrieval of obsolete files. Files can be restored to a different volume, and an index lists names and dates of all backup files. Linear speed is 90 inches per second, and the bit density is 8000 bits per inch. The average transfer rate is 28.9K bytes per second. Its error-checking modes are Check Sum, Read after Write, and Group Coded Recording. Verify Pass error checking is optional.

The Davong streaming tape backup costs $2195, including cabling, adapters,

software, and documentation. For additional information, contact Davong Systems, 217 Humboldt Court, Sunnyvale, CA 94089, (408) 734-4900.
Circle 732 on inquiry card.



Drive Subsystem for S-100 Bus

Digi-Data's Model 70S cartridge tape drive works with any 8080-, 8085-, or Z80-based S-100 bus computer. This device stores up to 17.3 megabytes of unformatted data. The transfer rate is 20K bytes per second. Record lengths are selectable from 256 to 32K bytes for a total formatted storage capacity of 16.6 megabytes. The maximum effective storage rate is 1.1 megabytes per minute. Up to eight units can be supported by a single S-100 controller board. The Model 70S operates as a nonintelligent I/O memory to the host.

Utility programs on 5¼- or 8-inch disks are provided. For complete particulars, contact Digi-Data Corp., 8580 Dorsey Run Rd., Jessup, MD 20794, (301) 498-0200.
Circle 733 on inquiry card.

Hard-Disk Subsystem for Z-100

Thought Works has announced the availability of Datafiles, a line of hard-disk subsystems for the Zenith Z-100 computer. Three storage capacities are offered: 5, 10, and 20 megabytes. Datafiles are self-contained systems, complete with intelligent controller, power supply, cabinet, and software. Hard wiring is not required because interconnection is accomplished by means of an interface board installed in a Z-100 slot and a ribbon cable. The software supports both CP/M and Z-DOS. Prices range from $2495 to $3995. For full specifications, contact Thoughtworks, 3532 West Thomas Rd., Phoenix, AZ 85019, (602) 269-6841.
Circle 734 on inquiry card.

Minifile Available with Two Capacities

The FDS-100 Minifile, a self-contained, intelligent 5¼-inch floppy-disk subsystem, is available in single-sided 89K-byte and double-sided 179K-byte versions. The basic Minifile features a microprocessor controller, power supply, and an RS-232C interface. Minifile's file-management functions are resident in firmware and controlled from a front-panel keyboard. System status and error information is communicated to the operator by means of a three-digit, seven-segment numeric display. A variety of switch-selectable options for data rates, number of stop bits, and hardware synchronization are provided.

Versions of the Minifile with an 8-bit parallel interface and dual RS-232C ports are available. The parallel interface model offers handshaking signals. The Minifile ranges from $1595 to $2295, depending on storage capacities. For more information, contact Atek NC Corp., 887 Main St., POB E, Monroe, CT 06468, (203) 268-1839.
Circle 735 on inquiry card.

Winchester Backup System

Mountain Computers' 10-megabyte cassette-tape drive backs up 5¼-inch Winchester hard-disk drives. This single-head four-track drive is for use with Apple and IBM Personal Computers and can record or transfer data at either 30 or 90 ips (inches per second). Average backup times are 12 minutes at 30 ips and 4 minutes at 90 ips. The transfer rate is 24K bytes per second at 30 ips and 72K bytes per second at 90 ips. ANSI-standard 450-foot cassette tapes are used.

The tape drive costs $1095. The controller interface is $295. Mountain Computer Inc., 300 El Pueblo Rd., Scotts Valley, CA 95066, (408) 438-6650.
Circle 736 on inquiry card.

3½-inch Winchesters on Market

Two versions of the Rodime PLC line of 3½-inch Winchester disk drives are available: the Model RO 351, a single-platter drive with 5 mega-

bytes of formatted storage, and the RO 352, which has twin platters for twice the storage. The 350 series drives use open-loop head/arm positioning with a double-precision stepper motor. Data records at 600 tpi with more than 11,000 bits per inch. The average access time is 85 milliseconds; track-to-track access time is 15 milliseconds. The data-transfer rate is 5 megabits per second. Physical dimensions are 1.625 by 4 by 5.25 inches—about one-quarter the volume of a standard 5¼-inch Winchester drive.

In OEM quantities, the Model RO 351 costs $555 and the RO 352 is $695. For more information, contact Rodime PLC, 25801 Obrero, Mission Viejo, CA 91291, (714) 770-3085.

Circle 737 on inquiry card.

PRINTERS

Olympian Letter-quality Printers

Olympia USA has introduced two letter-quality printers: the ESW3000 and the Electronic Compact RO. Both printers are microprocessor-controlled with bidirectional paper and carriage movement.

The 50-cps ESW3000 can handle forms up to 17 inches wide and has the ability to print 150, 180, and 255 characters per line in 10, 12, and 15 pitch, respectively. Print enhancements include boldface, expanded print, and double print. The ESW3000 uses a 100-character print wheel. It is available with a serial RS-232C, a Centronics-compatible parallel, or an IEEE-488 interface. A bidirectional forms tractor and sheet feeder are optional. It costs $1899.

The Electronic Compact RO has built-in serial and parallel interfaces that offer compatibility with a variety of computers. This printer operates at 14 cps and offers boldface and underline printing. Original plus four copies can be printed simultaneously, and it handles forms up to 14⅖ inches wide. The Compact RO prints 115 characters per line in 10 pitch, 138 in 12 pitch, and 172 in 15 pitch. It's outfitted with a forms tractor. The suggested price is less than $700. Contact Olympia USA Inc., POB 22, Somerville, NJ 08876, (201) 722-7000.

Circle 738 on inquiry card.

Color Plots in Less Than Three Minutes

Hewlett-Packard's HP 7475A can plot as fast as 15 inches per second to create a variety of multicolor pie, bar, line, and text charts in less than three minutes. This desktop-sized plotter has a 2g pen acceleration and uses a six-pen, drop-in carousel to produce a line resolution of 0.001 inches. Pens are selected from the carousel by either front-panel controls or through program commands. When returned to the carousel, the pens are automatically capped to prevent dry-out. Standard features include a pen-velocity command for special drawing conditions, a "view" mode that halts the plotting so that you can review the chart being produced, and the ability to rotate charts 90°, which simplifies adding horizontal charts into vertical formats. The HP 7475A accepts 11- by 17-inch paper and 8½- by 11-inch paper and overhead transparency film. Its dimensions are 22⅕ by 14½ by 5 inches.

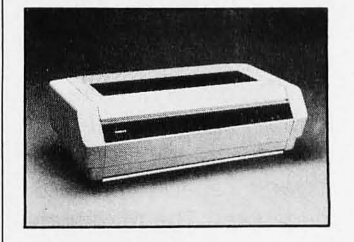
The HP 7475A is compatible with a broad range of computers and software from such manufacturers as Apple, Lotus, and IBM. Two interfaces are available: RS-232C and HP-IB, a Hewlett-Packard-enhanced version of the IEEE-488 bus. An optional cable lets you operate the plotter in series with a terminal when using the RS-232C interface. The list price for the HP 7475A is $1895. For full details, contact your local Hewlett-Packard sales office.

Circle 739 on inquiry card.

Multifunction Printer for Text and Graphics

The Facit 4528T intelligent printer prints text, matrix characters, and pin graphics at 165 cps. In its standard mode, this multipass unit produces near-letter-quality characters, unidirectionally or bidirectionally, with selectable standard, boldface, condensed, extended, and hybrid print styles. It offers pitches of 10, 12, or 17, proportional spacing, and the ability to print at 285 cps at 17 cpi. It offers continuous tractor-feed and multipart forms capability for original plus six copies. Paper length is programmable up to 18 inches.

An optional package lets you print variable-size

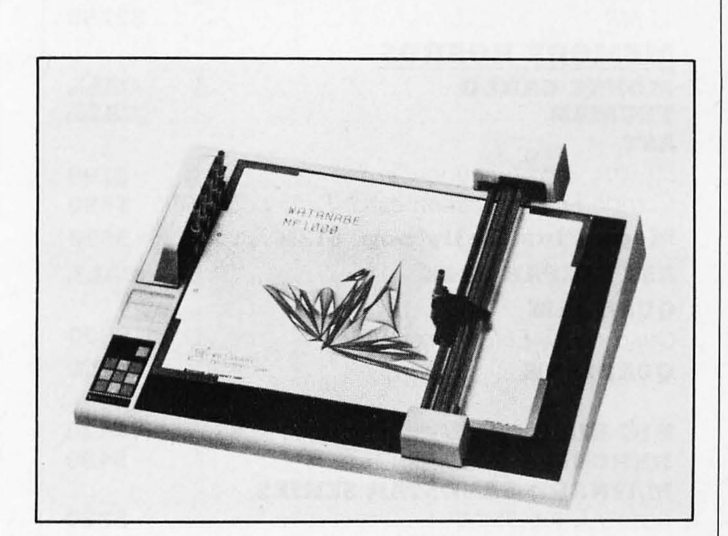


characters and up to nine different bar codes. Characters can be printed in any size, up to 9⅖ inches, and can be positioned sideways and upside down on

the same line. The 4528T can print formatted labels on paper, plastics, and thin metals, and it can create custom formats for specialized labels. Incrementing and decrementing counters are provided for sequential labeling and message variation. Up to 10,000 repeat-message label copies can be produced offline.

The Facit 4528T has a hinged cover with either a solid top with rear paper exit or a slotted top. It costs $1595. The variable-size and bar-code option is $400. Contact Facit Inc., 235 Main Dunstable Rd., Nashua, NH 03061.

Circle 740 on inquiry card.



6-Inch-Per-Second Plotter

The MP 1000 plotter from Watanabe Instruments Corporation has a plotting speed of 6 inches per second. It can operate with oil- or water-based fiber-tip pens or ink drafting pens. Six different pens can be automatically selected during the plotting process. A built-in single ASCII-character instruction set, said to be simple to access and use, lets you write programs for the plotter with minimal fuss. The MP 1000 can be equipped with three interfaces: serial RS-232C, GPIB IEEE-488, or 7- or 8-bit parallel.

The IEEE-488 and the parallel models cost $1190. The RS-232C version is $1090. Contact Watanabe Instruments Corp., 12 Chrysler St., Irvine, CA 92714, (714) 770-6010.

Circle 741 on inquiry card.

MISCELLANEOUS

Customize Your Computer Work Area

You can custom design your microcomputer workstation with Misco's line of modular furniture. The line is made up of computer and printer stands, a connecting leaf, a universal compartment, and a printer paper basket, all of which can be used individually or positioned in various configurations. These products feature a walnut-grain laminated top and black steel legs. Optional casters can be added to the stands. Prices begin at $24.95. The complete line costs $224.75. Contact Misco Inc., 404 Timber Lane, Marlboro, NJ 07746, (800) 631-2227; in New Jersey, (201) 946-3500.

Circle 742 on inquiry card.



Pair of Robots for the Home

Bob and Fred are a pair of robots from Androbot. Bob (brains-on-board) is built with an 8086 microprocessor, 3 megabytes of main memory, and 10 slots that house its components and provide for expansion capabilities. Bob can navigate a room and talk in a human-like voice. Infrared sensors attract it to humans, while ultrasonic sensors help Bob avoid inanimate objects. Options include Androwagon, which enables this robot to transport objects from room to room.

Fred (friendly robot educational device) is designed to serve as an introduction to robotics. It serves as a mobile extension of your home computer and can be programmed to perform a series of movements or operated independently by a remote infrared controller. Fred has the ability to execute on paper complex geometric shapes produced on a computer screen. It's packaged with a mini Androwagon for transporting small objects. Mechanical sensors detect edges, preventing Fred from falling off table tops.

Bob costs $2995. The optional Androwagon is $95. Fred costs $300. For complete information, contact Androbot Inc., 101 East Daggett Dr., San Jose, CA 95134, (408) 262-8676.

Circle 743 on inquiry card.

Where Do New Products Items Come From?

The information printed in the new products pages of BYTE is obtained from "new product" or "press release" copy sent by the promoters of new products. If in our judgment the information might be of interest to the personal computing experimenters and homebrewers who read BYTE, we print it in some form. We openly solicit releases and photos from manufacturers and suppliers to this marketplace. The information is printed more or less as a first-in first-out queue, subject to occasional priority modifications. While we would not knowingly print untrue or inaccurate data, or data from unreliable companies, our capacity to evaluate the products and companies appearing in the "What's New?" feature is necessarily limited. We therefore cannot be responsible for product quality or company performance.

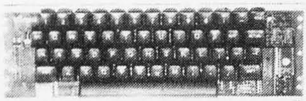
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CHECK SUNTRONICS NEW LOW PRICES

Apple Compatible Products

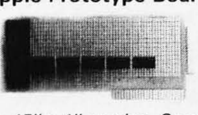


AFDC-1 Floppy Disk Drive Controller... **$79⁹⁵**
Runs DOS 3.3 with any standard Shugart compatible 5¼" Disk Drive. (2 Drives Each Card)



ASCII KEYBOARD A&T............... **$79⁰⁰**
Plug in compatible with Apple II, has shiftlock, underscore, [ ] and back slash characters.

Apple Prototype Board.



Double Sided glass with gold plated Apple and General Purpose terminals. Contains matrix of 17 x 63 solder plated donuts on .15" x .1" spacing. Great for 14, 16, and 24 pin IC's.

SUN-722 .... 7.95

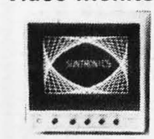
Apprate PROM Blaster 119.00
"ALS" 80 Column Card 159.00
"ALS" Z-CARD (Z80 CPU) 149.00
API Apple Parallel Printer Interface card. Centronics Compatible.................. $45.00

General Products

Mitsubishi Disk Drives, 5¼" and 8" Slim
5¼" Thin DSDD 40 Track.................. 310.00
8" Thin DSDD 77 Track.................. 450.00

General Products- cont.

Video Monitors





SAMWOO GREEN 9" 18MHz............ $115.00
SAMWOO AMBER 9" 18MHz 119.00
SAMWOO GREEN 12" 12MHz............ 124.00
SAMWOO AMBER 12" 12MHz 127.00
Composite video I/O. 750 lines resolution. 75/10K ohm impedance. Note: Please add $7.50 shipping and handling for the video monitors.

Assembled Connectors and Cables

Centronics Type Cable Assemblies 36 pin flat cable with male to male or male to female connectors.
4 ft.—**$24.95** 6 ft.—**$27.95**

RS232 Cable Assemblies 25 pin flat cable with male to male or male to female connectors.
5 ft.—**$29.95** 10 ft.—**$35.95**

Assemble Your Own Cables

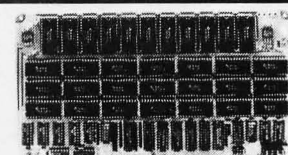
Cond.	Ribbon Cable Price/ft.	Card Edge Connector Price	IDS Socket Price	Header (w/w) Price
20	$0.50	$2.46	$3.06	$4.24
26	0.65	4.80	3.87	4.68
34	0.83	5.93	6.30	5.25
40	1.00	6.90	7.20	5.95
50	1.30	7.58	7.50	6.20

IDS DB-25P Connector $5.95
IDS DB-25S Connector $6.25

Super Sale

P/N	8-24	25up	P/N	8-24	25up
2716 (450nS)	3.80	3.55	6116P-3 (150nS)	6.10	5.75
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2532 (450nS)	5.95	5.95	4164	Call	Call
2764 (28 pin)	5.95	5.95	Z80A CPU	4.99	4.99

S-100 Products



S-100 MEMORY BOARD

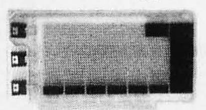
64KSM A&T without RAM.......... **$155⁰⁰**
64KSM A&T with 64k RAM (32-6116's) **339.00**
S-100 Board Uses 6MHz 6116's. ½A max. power. Bank Select plus Extended Addressing allow for multi-memory board set-up. 4 independant 16K Blocks make easy use with multi-user systems. Any 2K RAM may be replaced by 2716 EPROM.

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4MHz Z80A CPU boards with Serial Parallel Ports

UFDC-1 Floppy Controller, A&T 245.00
UFDC-1 Floppy Controller, Kit 225.00
The UFDC-1 Floppy Controller uses the WD1795 chip which runs either and/or 8" 5¼" Disk Drives

CLOCK CALENDAR A&T.................. **115.00**
CLOCK CALENDAR Kit **95.00**
This S-100 Clock Calendar Board has 4 interrupts, Time, Day of Week and Battery Backup.

S-100 Prototype Board



Double Sided glass with gold plated, numbered S-100 terminals. Matrix of 25 x 78 solder plated donuts on .15" x .1" spacing. Locations for headers and regulators. Great for 14, 16, and 24 pin IC's.

SUN-721 .... 12.95

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6	$12.00	$37.00	$52.00	$77.00
8	16.00	48.00	73.00	108.00
12	22.00	68.00	103.00	143.00

10MHz, No termination. Includes power indicator and wiring for muffin fan. Uses OKI connector for solderless installation and removal of power & reset lines.

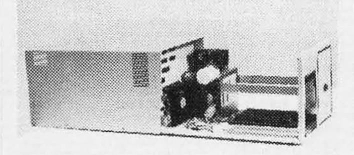
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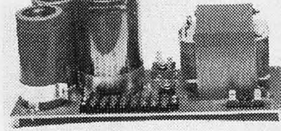
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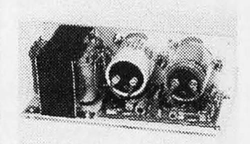
SUNNY LOW LOW COST POWER SUPPLIES
(LINEAR & SWITCHING) FOR S-100, DISK DRIVES



No. 806 & No. 516 Mainframes



Kit 1, 2 & 3 for S-100



R_2, R_3 for 2 Drives (Floppy & Hard)

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S_3, S_4 for S-100 & 2 Drives

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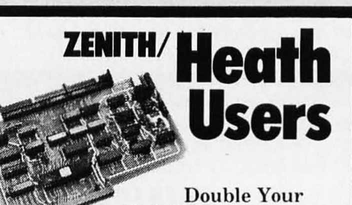
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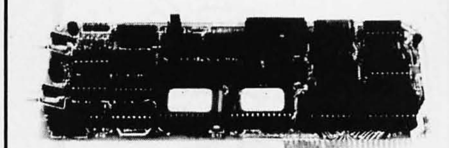
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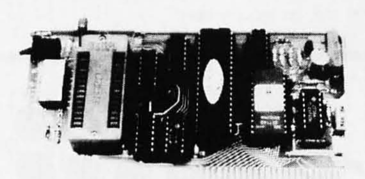
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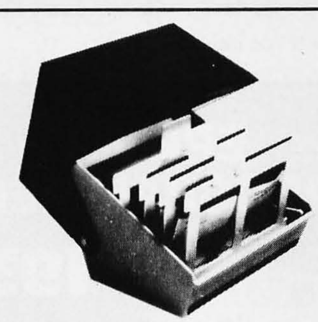
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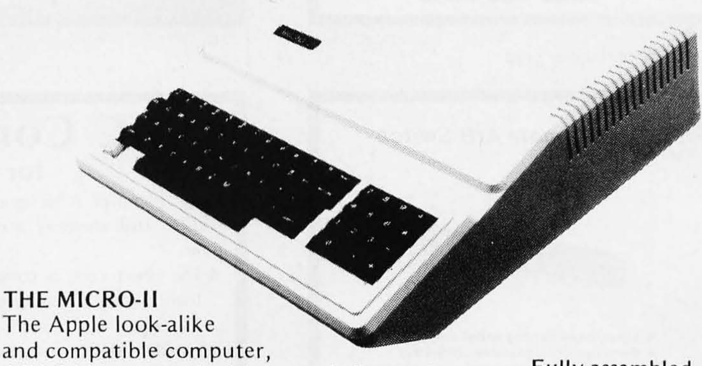
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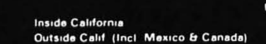
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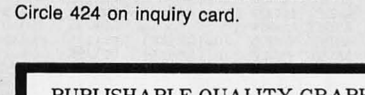
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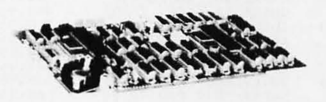
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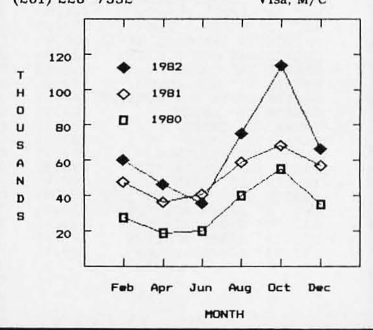
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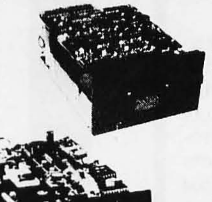
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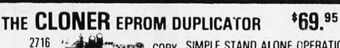
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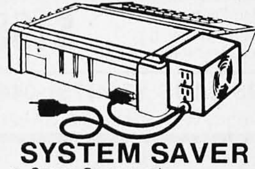
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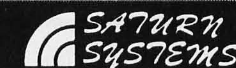
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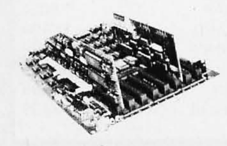
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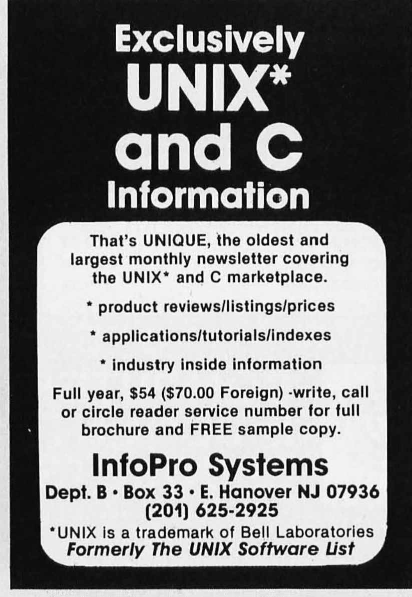
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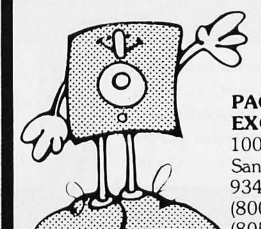
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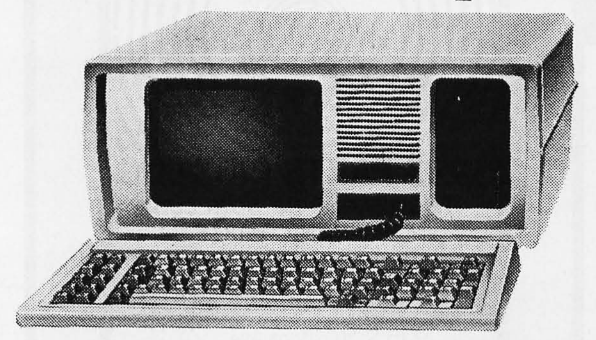
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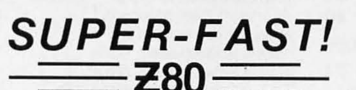
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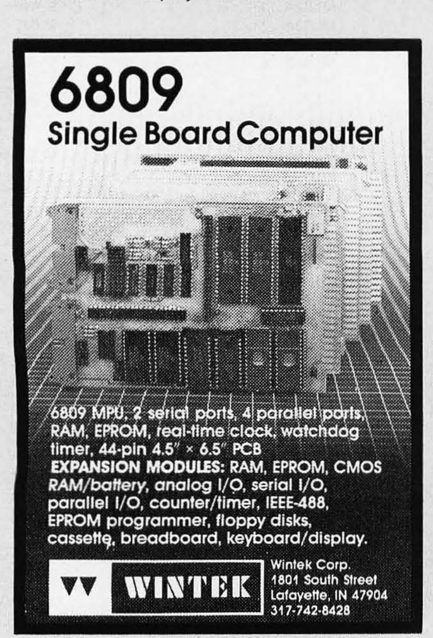
Memory management features: • Controls address lines A16-A23 • Is disabled with standard ADSB* signal.

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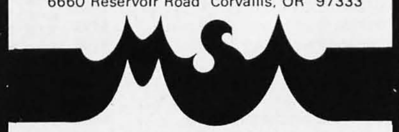
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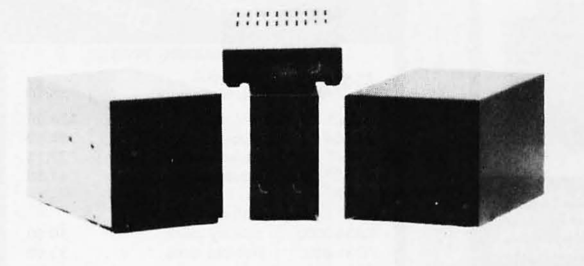
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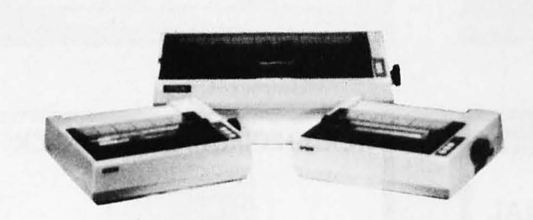
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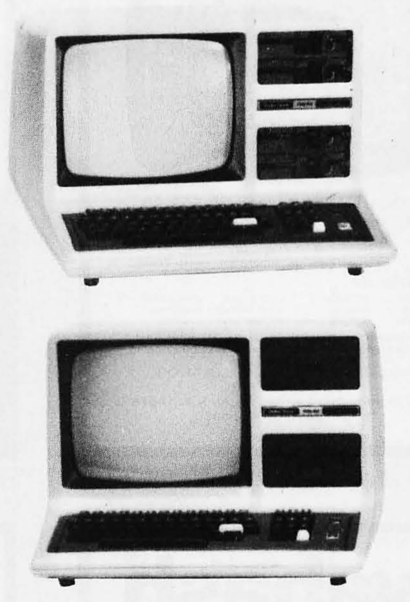
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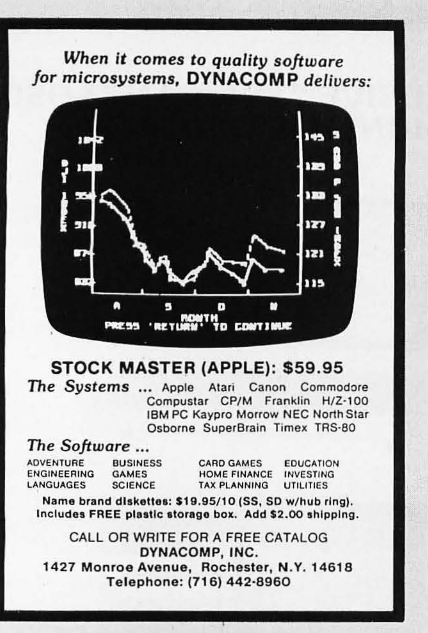
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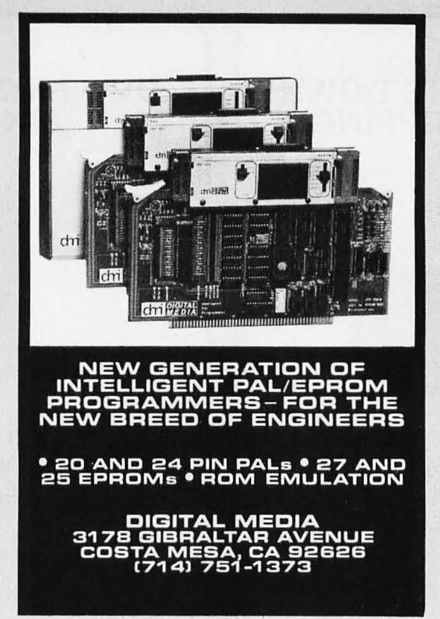
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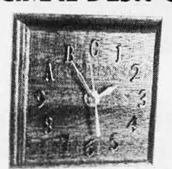
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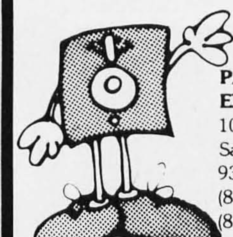
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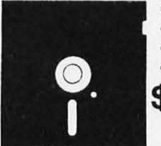
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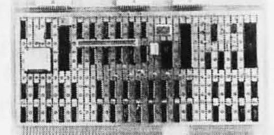
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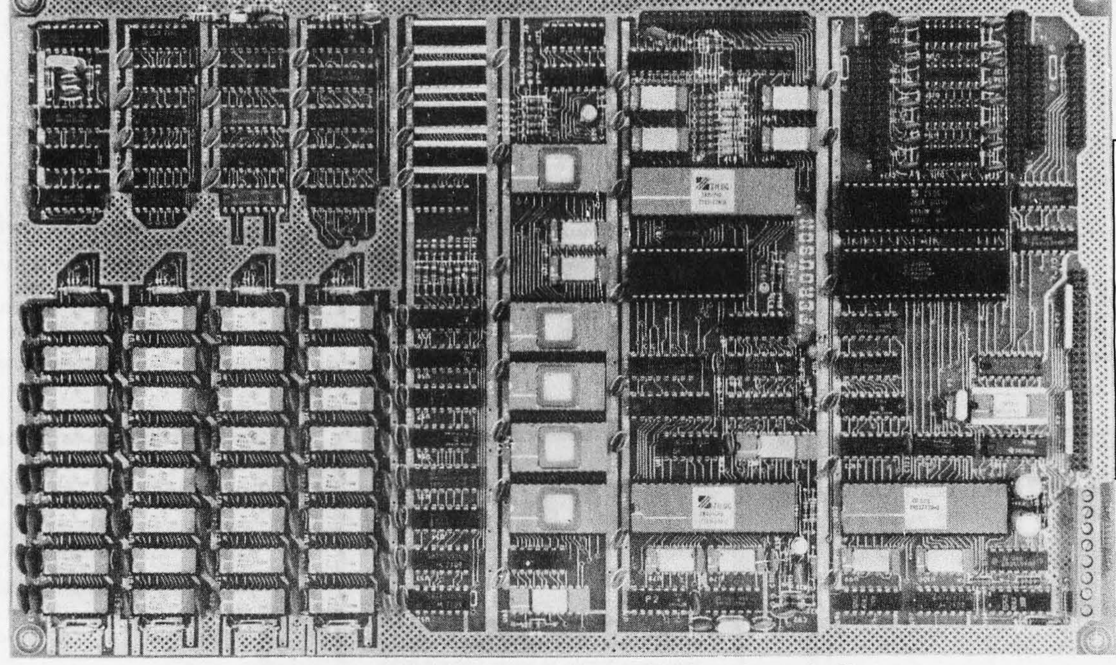
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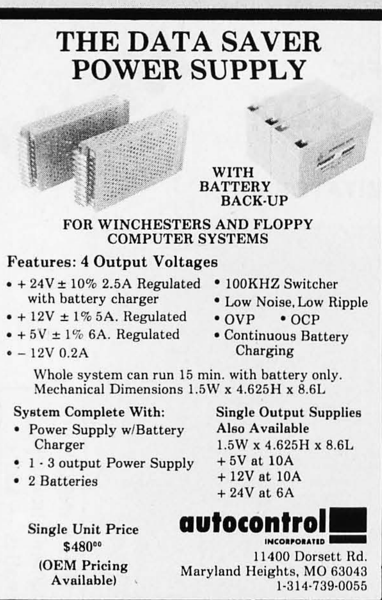
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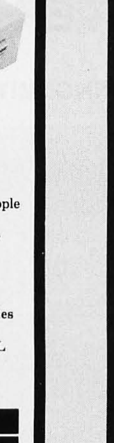
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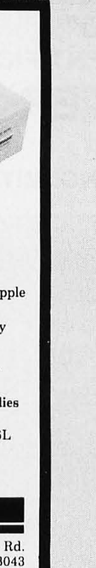
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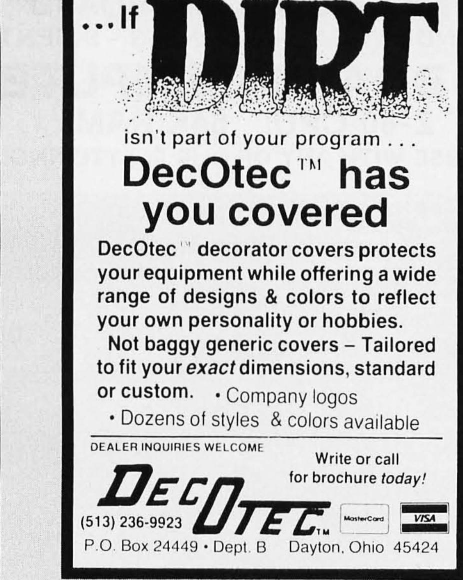
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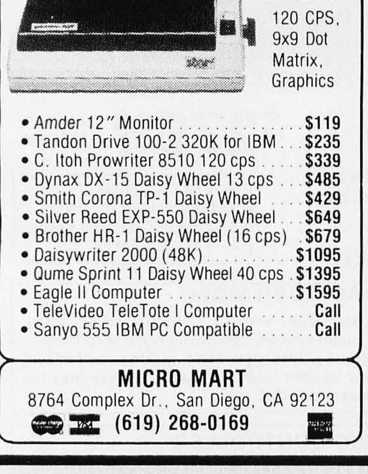
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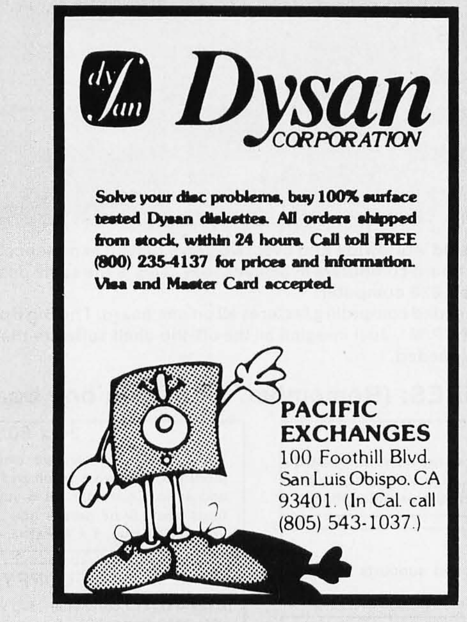
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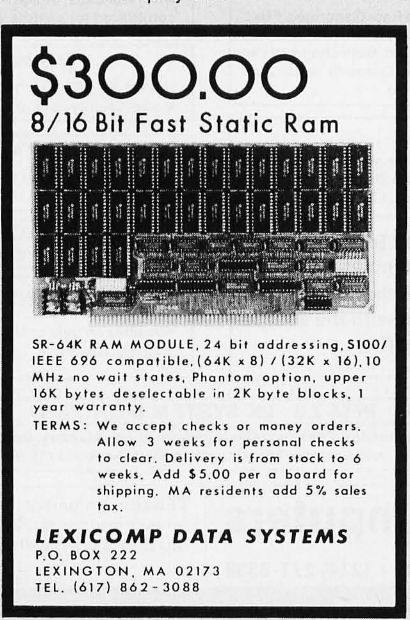
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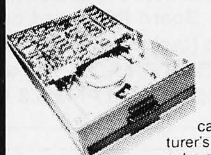
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'Password' with cables, sprk		$339
'Auto 212' dlxe		$419

DOT MATRIX	**PRINTERS**	LETTER QUALITY
GEMINI 10x 120 cps graphics		$289
PROWRITER 120 cps hi density		$319
JUKI daisy wheel 18 cps		$565
DAISYWRITER 40 cps		$999

CPM	**COMPUTERS**	IBM
Eagle	$CALL	Columbia P.C.
Kaypro	HARD DISKS	Corona P.C.
Televideo	PORTABLES	Eagle P.C.

IMAGE COMPUTERS
P.O. Box 1164, Cardiff, CA 92007

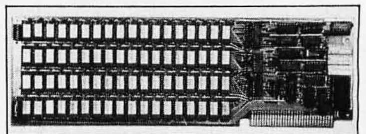
CALL TO ORDER:
619 436-7669
619 436-8317
VISA/MC ADD 3%

Circle 220 on inquiry card.



Circle 175 on inquiry card.

512K BYTE RAM for IBM PC — XT



$225 WITH 64K BYTES INSTALLED
$595 WITH 512K BYTES INSTALLED
$5.00 FOR 4164 CHIP [200NS ACCESS]

*1 YEAR WARRANTEE ON INSTALLED SYSTEM
*PARITY CHECK LOGIC
*ALL IC LOCATIONS SOCKETED
*MEMORY MAY BE LOCATED ON ANY 64K BOUNDARY
*SOME SPLIT ADDRESSING CAPABILITY
*TOTAL SPLIT ADDRESSING ON 64K BOUNDARY ON REQUEST

APPLIED LOGIC, INC.
PO BOX 328
JAMAICA, NEW YORK 11415
(212) 459-4064
prices subject to change without notice.

Circle 43 on inquiry card.



Circle 256 on inquiry card.



Circle 341 on inquiry card.

DISK DRIVES
(For PC, Mod I, III & IV)

Tandon TM55-2	$239
Tandon TM100-1	$189
Tandon TM100-2	$239
Tandon TM100-4	$339
CDC 9409	call.
Case and PS	$ 45

PC EXPANSIONS

MAYNARD
DISK CONTROLLER $155
PP add $50 SP add $70

QUADRAM
Quad bd. or Quad II (64K) $269

AST
Combo Plus: 64K & SPC $269
Mega Plus: 64K & SC $269
I/O Plus (SC) $114
2nd S or P or Game .... $ 35

64K CHIPS
Set of nine .... $ 55

EPSON
Printers .... call

VLM Computer Electronics
10 Park Place • Morristown, NJ 07960
(201) 267-3268 Visa, MC, Check or COD.

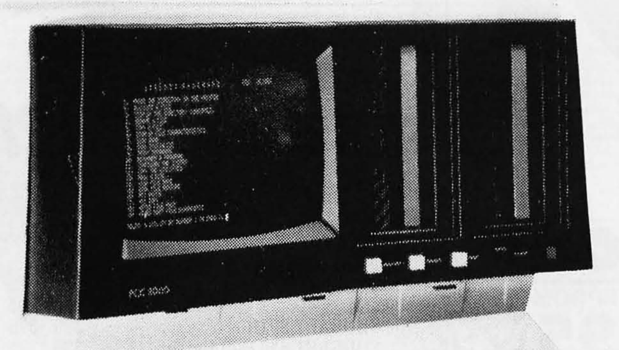
Circle 499 on inquiry card.

LIQUIDATION SALE



PERTEC 2000

MULTI-USER SYSTEM



Original Manufacturers Price $11,995

California Digital has recently participated in the purchase of several hundred Pertec 2000 microcomputers. These units are brand new 1983 production, shipped in factory sealed containers. California Digital is offering these multi-user systems at a fraction of its original price.

This microcomputer is the perfect low cost system for any business application requiring high reliability and multi-user flexibility.

The Pertec 2000 is an 8085 small business computer featuring dual 8" disk drives, 12" green phosphor screen and CPU integrated into a single compact unit with detachable keyboard. The keyboard features a numeric pad as well as a cursor control cluster. The Pertec 2000 is supplied with 64K/Byte of memory expandable to 256K. This system comes standard with both an RS-232 serial port as well as a Centronics parallel printer port. The computer will support two users and can be upgraded to a five user system.

The Pertec 2000 is supplied with Pertec BASIC, multi-tasking MTX operating system and CP/M 2.2. This computer is still in current production. Service as well as service contracts are available from Pertec.

GODBOUT COMPUPRO SALE

The CompuPro Corporation has recently relocated their facility to Hayward California. In the move, several logistic problems occured resulting in California Digital being double and even triple shipped pending orders. William J. Godbout, the president of CompuPro, has asked us to liquidate the excess inventory rather than send the product back to Hayward.

In order to clear our warehouse, we are offering these boards at a substantial savings. We are, however, asking for prepayment on these orders because of the low profit involved. A surcharge may be added to credit card or open account purchases.

CPU 68K is the most advanced 68000 board available. It includes sockets for an optional memory management unit and up to 16K bytes of EPROM.

GBT-68K	Assembled	695	499
GBT-68KC	CSC	850	619

CPU 86/87 lets you take advantage of the 8086's large library of ultra-efficient 16 bit software. Includes sockets for 8087 math co-processor and 80130 firmware chips.

GBT-8687	Assembled	750	545
GBT-8687C	CSC	850	619

CPU 8085/8088 is the original, much imitated dual processor board. When you need the best of both worlds 8 bit and 16 bit microprocessor application the Compupro dual processor board delivers results.

GBT-8588	Assembled	495	359
GBT8588C	CSC	595	429

CPU Z is the premium 8 bit CPU that includes all standard Z80A features along with all the necessary options to insure backward compatibility with most older S-100 mainframes.

GBT-Z80	Assembled	325	239
GBT-Z80C	CSC	425	319

CPU 16032 features the National NSC 16032 that has true 32 bit internal architecture which resembles that of a minicomputer.

GBT-16032	Assembled	pending
GBT-16032C	CSC	pending

CPU 286 is based around Intel's iAPX 286/10 sixteen bit microprocessor. Upward compatible from the Compupro 8085/8086.

GBT-286	Assembled	1595	1147
GBT-286C	CSC	1750	1259

MEMORY BOARDS

RAM 16 is 64 K/Byte of high speed (10 MHz) low power static memory. This board performs both 8 bit and 16 bit data transfers insuring complete compatibility with all 696/S-100 microcomputer systems.

GBT-R16	Assembled	550	399
GBT-R16C	CSC	650	469

RAM 17 provides 64 K/Byte of 8 bit static memory. DMA data transfer and 24 bit extended addressing make the RAM 17 the new economicalstandard.

GBT-R17	Assembled	399	289
GBT-R17C	CSC	499	359

RAM 21 features 128 K/Byte of low power static memory. This board is capable of doing both 8 bit and/or 16 bit DMA data transfers.

GBT-R21	Assembled	1095	789
GBT-R21C	CSC	1245	899

RAM 22 is 256K/Bytes of high speed low power static memory. This board does both 8 and/or 16 bit data transfers at 12 MHz.

GBT-R22	Assembled	1750	1250
GBT-R22	CSC	1895	1350

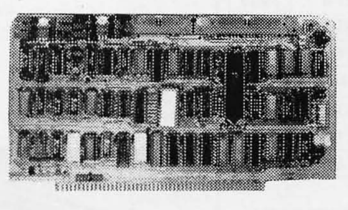
M-DRIVE/H emulates 512 K/Bytes of floppy disk storage in solid state memory. System down loads data from magnetic storage and stores this information in dynamic RAM increasing performance by as much as 3500%.

GBT-MDH	Assembled	1895	1365
GBT-MDHC	CSC	2095	1495

DISK CONTROLLERS

DISK 1 provides advanced capabilities required by today's single or multi-user microcomputers. Disk 1 incorporates the NEC765 controller LSI circuit in an unequaled floppy disk board featuring DMA arbitration.

GBT-DSK1	Assembled	495	359
GBT-DSK1C	CSC	595	429



DISK 2 interfaces to most 8" and 14" Winchester disk drives. Directly accesses upto 16 M/Byte. The Disk 2 allows your hard Winchester system to operate at its peak potential by providing high speed DMA transfers required by sophisticated microcomputer systems.

GBT-DSK2	Assembled	795	575
GBT-DSK2C	CSC	895	649

DISK 3 controls upto four Seagate 506 compatible 5¼" Winchester disk drives. On board processor relieves host CPU of disk overhead enhancing performance of entire system.

GBT-DSK3	Assmebled	795	575
GBT-DSK3C	CSC	895	645

INTERFACER 1 features two independently addressable RS-232 I/O ports. Each port is baud rate selectable from 50 to 19,200 allowing for simultaneous driveing of fast and slow devices.

GBT-133A	Assembled	295	219
GBT-133AC	CSC	370	269

INTERFACER 2 provides three fully duplexed parallel ports, each containing 16 latched data lines along with strobe, enable and attention. One RS-232 port is included is this unique interface.

GBT-150A	Assembled	325	235
GBT-150AC	CSC	399	289

INTERFACER 3 is an eight channel multi-user serial I/O board designed for high performance industrial and scientific applications. The Interfacer 3 is capable of high speed synchronous communications with baud rates up to 250K.

GBT-138A	Assembled	599	429
GBT-138AC	CSC	699	499

INTERFACER 4 is really the only interface board most systems will require. The Interfacer 4 consists of two async./sync. and one async. RS-232 port with 5 handshaking lines. The board also is equiped with a Centronics parallel printer port.

GBT-187A	Assembled	450	325
GBT-187AC	CSC	540	389

SYSTEM SUPPORT incorporates the most popular and most needed system support functions onto one single board. 4K/Bytes of EPROM, battery back up, clock calendar and three 16 bit interval timers are among some of the features of this special purpose board.

GBT-SYS1	Assembled	450	325
GBT-SYS1C	CSC	550	395

California Digital

Post Office Box 3097 B • Torrance, California 90503

TOLL FREE ORDER LINE (800)421-5041

TECHNICAL & CALIFORNIA (213)679-9001

California Digital

Post Office Box 3097 B • Torrance, California 90503



Plastic library case supplied with all diskettes purchased from California Digital

$19.95

New Low Price

Private labeled for California Digital by one of the most respected producers of magnetic media. Each diskette is certified double density at 40 tracks. To insure extended media life all diskette are manufactured with a reinforced hub.
Each box of diskettes is supplied with a free plastic library case.
Soft sector CAL-501, Ten sector CAL-510

Scotch
skettes

minidisks
Verbatim

5¼" DISKETTES WITH LIBRARY CASE

$26.50

Your Choice
SCOTCH
MEMOREX
VERBATIM

Single Side Double Density

	Soft Sector	10 Sector	16 Sector	
SCOTCH	744D-0	744D-10	744D-16	26.50
MEMOREX	3481	3483	3485	26.50
VERBATIM	525-01	525-10	NA	26.50
MAXELL	MD1	MH1-10	MH1-16	26.50
DYSAN	104/1D	107/1D	NA	45.00

Double Side Double Density

SCOTCH	745-0	745-10	745-16	39.00
VERBATIM	550-01	550-10	NA	42.50
MAXELL	MD2-D	MH2-10D	MH2-16D	45.00
DYSAN	104/2D	107/2D	NA	49.50
DYSAN 96	204/2D	NA	NA	59.50

EIGHT INCH DISKETTES

Single Side Single Density

SCOTCH	740-0	29.50
MEMOREX	3060	29.50
DYSAN	3740/1	39.50

Thirty Two Sector

SCOTCH	740-32	29.50

Single Side Double Density

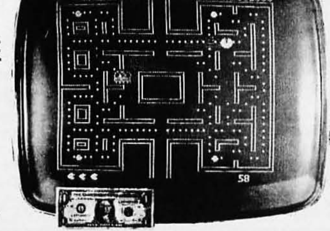
SCOTCH	741-0	39.00
MEMOREX	3090	35.00
DYSAN	3740/D	57.50

Double side Double Density

SCOTCH	743-0	47.50
MEMOREX	3114	39.50
DYSAN	3740/2D	65.00

Flip & File 5¼" stores 50 disk	INC-525	18.95
Flip & File 8" stores 50 disk	INC-800	22.85
Scotch head clean kit 5¼ & 8"	MMM-ck5	24.95
Plastic library cases 5¼ & 8"	SRW-L5	2.95

23" COMPOSITE MONITOR $159



Ideal monitor for classroom demonstrations.

Ever try gathering a classroom of students around a 12" monitor? Here is your opportunity to purchase a 23" high resolution monitor at a reasonable price.
These units accept standard composit video signals generated by most personal computers including the Apple and IBM. Attach it your computer and in second you are shooting down Klingons in wide screen video.
MOT-BW23 35 Lbs. Monitors are open frame and for safety should be enclosed. Wood grained enclosure for above $35.00 additional CAL-ENC23 15 Lbs.

SPECIAL

Shugart 410

$129

These Shugart 410 5¼" disk drives are all factory fresh 1983 production, recently purchased from the Four Phase Division of the Motorola Corporation.
These disk drives are **single sided 80 track** (96 TPI) suitable for use with the Radio Shack Model 1 and Model 3. Or any other application that can support an 80 track second drive such as the IBM/PC. The 410 is full height and functionally the same as the Tandon TM 100-3. Complete with power connector and installation manual.
When these Shugart 410's are liquidated the price will revert to our regular price of $249. SHU-SA410

MEMORY

16K DYNAMIC **1.95** 4116 150ns.	2732 EPROM **4.95** 450ns.
64K DYNAMIC **5.95** 4164 150ns.	16K STATIC **4.95** 6116 200ns.

CAL

2764 EPROM SALE $5.95

DYNAMIC MEMORY

		1-31	32 +	100 +
4027 4K dynamic 250ns	ICM-4027250	1.99	1.85	1.75
4116 150ns 16K	ICM-4116150	1.95	1.85	1.75
4116 200ns 16K	ICM-4116200	1.85	1.75	1.65
4164 150ns 64K 128 refresh	ICM-4164150	5.95	5.75	5.55
41256 150ns 256K	ICM-41256150	Available Jan 84		

STATIC MEMORY

21L02 200ns 1K static	ICM-21L02200	1.49	1.29	1.15
21L02 450ns 1K static	ICM-21L02450	1.29	1.15	99
2112 450ns 2K static	ICM-2112450	2.99	2.85	2.75
2114 300ns 1K x 4	ICM-2114300	1.95	1.85	1.75
4044TMS 450ns 4K x 1	ICM-4044450	3.49	3.25	2.99
5257 300ns 4K x 1	ICM-5257300	2.50	2.25	1.99
6116 P4 200ns 2K x 8	ICM-6116200	4.50	4.75	4.55
6116 P3 150ns 2K x 8	ICM-6116150	4.95	4.75	4.60
6167 2167 100ns 16K x 1 (20 pin)	ICM-6167100	7.95	7.50	7.90

EPROMS

2708 450ns 1K x 8	ICE-2708	4.95	4.75	4.55
2716 450ns 2K x 8	ICE-2716	4.95	4.75	4.55
2716TMS 450ns Tri-voltage	ICE-2716TMS	7.95	7.65	7.25
2732 450ns 4K x 8	ICE-2732	4.95	4.75	4.55
2732 350ns 4K x 8	ICE-2732350	8.50	8.00	7.60
2532 450ns 4K x 8	ICE-2532	10.50	9.90	9.50
2764 350ns 8K x 8	ICE-2764	5.95	5.65	4.97
27128 350ns 16K x 8	ICE-27128	29.95	28.32	27.46

CONNECTORS

S-100 Gold

DB25P

GOLD S-100 EDGE CARD CONNECTORS

	catalog	each	10-99	100+
Imsai s/t .250"	CNE-IMS	2.95	2.50	2.19
Sullins Hi/Rel.	CNE-H100	4.19	3.85	3.47
S-100 Wire W	CNE-W10	3.95	3.50	3.19
Altair .140" s/t	CNE-100A	4.95	4.50	4.19

.156" CENTER EDGE CARD CONNECTORS

22/44 Eyelet	CNE-44E	2.50	2.15	1.95
43/72 Moto. s/t	CNE-72S	6.60	6.15	5.75
36/72 D/G s/t	CNE-72S	5.95	5.50	5.19

Other connectors available upon request

RIBBON CONNECTORS

DB25P male	CND-r25P	5.65	5.25	4.15
DB25S female	CND-r25S	5.95	5.59	4.50
57-30360 male	CNC-r36P	7.95	6.75	5.90
57-30360f male	CNC-r36S	7.95	6.75	5.90
20 pin edge	CNI-DE20	4.35	3.30	2.50
20 pin socket	CNI-DS20	2.75	1.85	1.60
26 pin edge	CNI-DE26	4.95	3.50	2.70
26 pin socket	CNI-DS26	3.50	2.40	2.15
34 pin edge	CNI-DE34	4.95	4.50	3.50
34 pin socket	CNI-DS34	4.50	3.95	3.15
50 pin edge	CNI-DE50	5.95	5.60	4.90
50 pin socket	CNI-DS50	4.95	4.60	3.80

"D" TYPE	catalog	each	10-99	100+
DE9P male	CND-9P	1.60	1.40	1.30
DE9S female	CND-9S	2.25	2.00	1.30
DE hood	CND-9H	1.50	1.35	1.20
DA15P male	CND-15P	2.35	3.10	2.90
DA15S female	CND-15S	3.25	3.10	2.90
DA15 hood	CND-15H	1.60	1.35	1.30
DB25P male	CND-25P	2.50	1.95	1.65
DB25S female	CND-25S	3.35	2.75	1.95
DB25 hood	CND25H	1.35	1.15	77
DC37P male	CND-37P	4.20	3.95	3.65
DC37S female	CND-37S	5.95	5.75	5.50
DC37 hood	CND-37H	2.25	1.95	1.65
DD50P male	CND-50P	5.50	5.10	4.75
DD50 hood	CND-50H	2.60	2.40	2.10
Hardware 2/set	CND-2HS	99	69	42

AMPHENOL / CENTRONICS TYPE

57-30360 36/P	CNC-36P	7.95	6.35	4.90
IEEE488, C dor	CND-24P	7.95	6.35	5.35

DISK DRIVE POWER CONNECTORS

8" 6 pin D.C.	CNP-6DC	1.95	1.29	.89
8" 3 AC Sgl/S	CNP-3SS	1.69	1.09	69
8" 3 AC Dbl/S	CNP-3DS	1.69	1.09	69
5¼" 4 pin D.C.	CNP-4DC	1.79	1.19	99
3 pin DIN recpt.	CNP-D3P	2.59	1.99	1.59

BLOWOUT SALE

$169

California Digital has recently participated in the purchase of several thousand Siemens FDD 100-8 floppy disk drives. These units are electronically and physically similiar to that of the Shugart 801R. All units are new and shipped in factory sealed boxes. Manual and power connectors supplied free upon request. Your choice 115 Volt. 60 Hz. or 230 Volt. 50Hz.

NOTE! European customers, we have a large quantity of 230 volt 50 Hz. units warehoused in Frankfort Germany. Arrangements can be made to will call these drives in quantities of 50 or more in Frankfort reducing import duty and freight charges.

REMEX DOUBLE SIDED $219

California Digital has just purchased a large quantity of Remex RFD-4000 **Eight inch double sided** disk drives. Remex is the only double sided disk drive that has an double gimbal mounted head assembly that guaranties lower head tracking. This drive is mechanically solid. Remex has always been known for producing premiere products for the floppy disk market. The Remex company is a subsidiary of the Ex-cell-o Corporation, a Fortune 500 Company.

Eight Inch Single Sided Drives

	One	Two	Ten
SHUGART 801R	385	375	365
SHUGART 810 Half Height	385	375	365
SIEMENS FDD 100-8	169	169	159
TANDON 848E-1 Half Height	369	359	349

Eight Inch Double Sided Drives

SHUGART SA851R	495	485	475
SHUGART 860 Half Height	495	485	475
QUME 842 "QUME TRACK 8"	459	459	449
TANDON 848E-2 Half Height	485	475	465
REMEX RFD-4000	219	219	209
MITSUBISHI M2894-63	379	375	369
MITSUBISHI M2896-63 Half Ht.	459	449	409

Five Inch Single Sided Drives

SHUGART SA400L	235	229	225
SHUGART SA410 96TPI/80 Trk.	*129*	*119*	*call*
SHUGART SA200 ⅔ Height	169	159	149
TANDON TM100-1	189	179	175
TANDON TM50-1 Half Height	465	450	439
TEAC FD-55A Half Height	465	459	445

Five Inch Double Sided Drives

SHUGART SA450	319	309	299
SHUGART SA455 Half Height	259	249	239
SHUGART SA465 Half Ht. 96TPI	289	279	269
TANDON TM50-2 Half Height	215	209	199
TANDON TM55-4 half Ht. 96TPI	329	319	309
TANDON 100-2	279	269	259
TANDON 101-4 96TPI 80 Track	369	355	350
MITSUBISHI 4851 Half Height	259	249	245
MITSUBISHI 4853 ½ Ht. 96TPI	339	329	319
MITSUBISHI 4854 ½ Ht., 8" elec.	465	449	439
QUME 142 Half Height	239	229	219
TEAC FD-55B Half Height	329	319	299

Five Inch Winchester Hard Disks Drives

SHUGART 612	13 M/Bytes	895	865	825
SHUGART 706	6 M/Byte, Half Ht	795	775	755
SHUGART 712	13 M/Byte, ½ Ht.	895	865	825
SEAGATE 506	6 M/Byte	555	495	475
TANDON 503	12 M/Byte	895	875	855

Upon request, all drives are supplied with power connectors and manual

ENCLOSURES

California Digital manufactures an asortment of stock and custom disk drive enclosures. If the volume is justified we will custom design an enclosure for your application. The following stock disk drive enclosures are available. All include power supplies the 8" enclosures are supplied with exhaust fans.

Horizontal mount two 8" full height drives. $279.00
Vertical mount two full height 8" disk drives. $299.00

Horizontal mount one full height or two half height 8" disk drives. $239.00
Vertical mount two full height 5¼" disk drives $139.00



Shipping: First five pounds $3.00. Each additional $.50.
Foreign orders: 10% shipping. Excess will be refunded.
California residents add 6½% sales tax. COD's discouraged.
Open accounts extended to state supported educational institutions and companies with a "strong" Dun & Bradstreet.
Warehouse: 15608 Inglewood Blvd.

TOLL FREE ORDER LINE
(800) 421-5041
TECHNICAL & CALIFORNIA
(213) 679-9001

California Digital

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OCR READER

RECOGNITION EQUIPMENT



$295

ASCII OUTPUT

OCR "A" ABOVE.

One of our best selling liquidations is again available. This OCR readers was manufactured by Recognition Equipment Incorporated for the TRW Corporation. Used in their point of sale cash register systems currently in use at the Sears Roebuck and J.C. Penney retail stores.

These OCR readers are suitable for inputing data for inventory control, point of sale or any application where accuracy and speed are essential. Units should easily interface to most microcomputer such as Apple and S-100 systems.

Interfaces eight bit ASCII parallel with "handshaking". Controller has 11 user accesable registers that are software controllable, minimizing double entry of data. The OCR wand reads a subset of "OCR A" as fast as 10 characters per second. Print wheels are available for most daisy wheel printers as well as electric typewritters.

Documentation and application notes are included. Each reader is brand new in factory sealed boxes. Original acquisition is aprox. $2,500. OCR-720 15 lbs.

LIBERTY FREEDOM 50 $475

The Liberty Freedom 50 terminal features detachable keyboard with 93 keys including 10 function keys, 15 graphic symbols, and DIP switch selectable character set for 7 foreign languages. The 12 inch etched non-glare green phosphor screen displays 24 rows by 80 characters in 7x9 matrix with true descenders. Self test and 25th data display row also included. Switch selectable baud rates from 110-19,200 baud. Screen attributes do not use display memory, allowing operator to display a full 1920 characters. Emulates 5 popular CRT terminals for easy software configuration. Switch selectable between 115 and 230 volt. We have never seen a terminal with all these features for the incredibly low price of only $475. LIB-F50 40 lbs.

DIABLO

Word Processing Printer

$879

Now from the originator of the daisy wheel printer, the Diablo 620. Print speeds to 24 char/sec., user selectable bi-directional printing, superscripts, subscripts, graphics and more. Plus standard RS-232 interfacing. Communication speeds to 1200 baud with a 1500 character print buffer. Software programable absolute horizontal tabs makes report formatting easy. Over 20 different print wheels are currently available. The 620 automatically selects the print spacing for 10, 12, 15 char/inch print wheels. On site service available worldwide. DBL-620 50 lbs.

FREE

Your Choice
SECOND DRIVE
GREEN MONITOR



SANYO $995

IBM COMPATIBLE

Sanyo Electronics has just released the long awaited IBM/PC look-a-like, the MBC-555. This is a complete microcomputer that includes a 5¼" 160 K/Byte disk drive, 128K/Byte of memory, color graphics interface, low profile keyboard, and parallel printer port. Also includes extensive software such as Sanyo Basic, disk utilities, word processing, and spread sheet program. MS-DOS is supplied with the Sanyo computer allowing programs written for the IBM/PC to operate on the MBC-555.

Along with all this California Digital offers "FREE" your choice of either a second disk drive or a high resolution green phosphor monitor. All at the super low price of only $995.00.

We expect to see a initial shortage of this item. MBC-555's will be shipped on a first ordered basis. Please place your order early.

PRINTERS



$299 Star Gemini

MATRIX PRINTERS

Star Gemini-10X 120 char/sec 4K buffer	STR-G10X	299.00
Star Gemini-15, 100 char/sec 15" paper	STR-G15	399.00
Star Coex 80FT friction & tractor	VST-C80FT	229.00
Toshiba P1350, 192 char/sec letter quality	TOS-1350	1499.00
Okidata 82A serial & parallel 9½" paper	OKI-82A	419.00
Okidata 92A parallel interface 160 char/sec	OKI-92A	499.00
Okidata 83A & parallel 15" paper	OKI-83A	629.00
Okidata 84A & parallel 15" paper	OKI-84A	969.00
Okidata 2350 (new) 350 char/sec	OKI-2350	1995.00
Epson FX80, 10" 160 char/sec with graphtrax	EPS-FX80	575.00
Epson MX100 with graphtrax, 15" paper	EPS-MX100	695.00
NEC8023A parallel 9½" paper, graphics	NEC-8023A	395.00
Anadex 9501A high speed with graphics	ADX-9501A	1119.00
Anadex 9620A 200 char/sec par l & serial	ADX-9620A	1229.00
Datasouth 180 high speed 180 cps 15"	DSI-180	1295.00
Quantex 7030 corespondence quality 180 char/sec	QTX-7030	1595.00
Gorilla low cost dot matrix printer	PRO-7500	209.00
Prowriter 8510 parallel 9½" paper	PRO-8510P	495.00
Prowriter 8510 serial 9½" paper	PRO-8510S	639.00
Prowriter II, parallel 15" paper, graphics	PRO-2P	750.00
Printronix P300 high speed printer 300 lines per minute	PTX-P300	4500.00
Printronix P600 ultra high speed 600 lines per minute	PTX-P600	6150.00
Mannesmann Tally 160L serial & par l, 160 char/sec	MAN-160L	695.00

WORD PROCESSING PRINTERS

NEC7710 55 char/second, serial interface	NEC-7710	1995.00
NEC7730 55 char/sec. par l interface	NEC-7730	1995.00
Silver Reed EXP500, 14 char/sec par l interface	SRD-EXP500	595.00
Silver Reed EXP550 17 Char/sec par l interface	SRD-EXP550	759.00
Diablo 630 40 char/sec serial	DBL-630	1895.00
Diablo 620, proportional spacing, horz & vert. tab. 20 cps	DBL-620	879.00
Juki 6100, 18 char/sec graphic mode	JUK-6100	565.00
Brother HR1A daisy wheel, parallelinterfacing	BTH-HR1P	779.00
Brother HR1A serial interface	BTH-HR1S	839.00
Starwriter F10 serial, 40 char/sec	PRO-F10S	1475.00
Starwriter F10 parallel, 40 char/sec	PRO-F10P	1475.00

EPSON MX80 RIBBONS $6.95

MONITORS

BMC 12A green phosphor 15 MHz composit video	BMC-12A	88.00
BMC 12" high resolution, 20MHz	BMC-12EN	139.00
Zenith ZVM121 green phosphor 12" 40/80 column switch	ZTH-Z121	109.00
NEC JB1201 green phosphor 18 MHz composit video	NEC-JB1201	169.00
NEC JB1260 commercial grade composit	NEC-JB1260	129.00
USI Amber screen 12" composit monitor	USI-12A	169.00
Motorola 23" open frame blk/white composit video	MOT-BW23	159.00
Motorola 12" open frame requires horz sync. and power	MOT-BW12	69.00
Conrac 9" open frame requires horz sync. & 12v. supply	CON-BW9	59.00
COLOR		
BMC AU9191U Color composit video with sound	BMC-9191	279.00
BMC 9191M RGB designed for use with the IBM computer	BMC-9191M	499.00
NEC JC1203DM, RGB color monitor	NEC-1203	699.00
NEC JC1201 color composit	NEC-JC1201	339.00
Zenith ZVM134 RGB color suitable for IBM PC	ZTH-Z134	595.00
Comrex color composit with sound	COM-6500	329.00
Amdek Color 1, composit video	AMK-100	329.00



MODEMS

DIRECT CONNECT
$75.00

Hayes Smart Modem 1200 baud, auto answer, auto dial	HYS-212AD	515.00
Hayes Smartmodem, 300 baud only, auto answer, auto dial	HYS-103AD	229.00
Hayes Micromodem II, 103 Apple direct connect	HYS-MM2	279.00
Hayes Micromodem 100, S-100 auto answer, auto dial	HYS-100	319.00
Hayes Chronograph, time & date	HYS-CHR232	199.00
U.S. Robotics 212A 300/1200 baud, auto dial/answer	USR-212A	419.00
Penril 300/1200 auto dial,autolog	PEN-12AD	695.00
Universal Data 103LP, line power, answer & originate	UDS-103LP	169.00
Universal Data 103LPJ, Auto answer	UDS-103LPJ	219.00
Universal Data 202, 1200 baud, half duplex only	UDS-202LP	219.00
Universal Data 212LP, full 1200 baud duplex, line power	UDS-212LP	359.00
Novation J Cat, direct connect, auto answer	NOV-JCAT	109.00
Novation Cat, acoustic connect	NOV-CAT	159.00
Novation SmartCat 103, auto answer, auto dial	NOV-SC103	219.00
Novation SmartCat 103/212, 1200 baud auto dial	NOV-SC212	529.00
Signalman Mark 1, direct connect with terminal cable	SGL-MK1	75.00

TERMINALS



The Wyse 100 features die cast aluminum case, 102 key keyboard and non-glare 26 line green phosphor video display. Split screen both horizontal an vertical makes the WY-100 unusally user friendly. This unique terminal is perfect to enhance any business system.

$795

Freedom 50, split screen, detatchable keyboard	LIB-F50	475.00
Visual 50, detatchable, keyboard selectable settings.	VSL-50	659.00
Visual 50 Green screen	VSL-50G	679.00
Visual 330, emulates DEC, DG, LSI, green	VSL-330G	995.00
Ampex Dialogue 125 green screen, two page, func. keys	APX-D125G	695.00
Ampex Dialouge 125 amber screen, two page, func. keys	APX-D125A	685.00
Wyse 100, horz & vert. split screen, metal enclosure	WYS-100	795.00
Wyse 300, Eight color display, split screen	WYS-300	1159.00
Televideo 910 Plus, block mode	TVI-910P	595.00
Televideo 925, detatchable keyboard, 22 function keys	TVI-925	795.00
Televideo 950, graphic char.,split screen, 22 func	TVI-950	985.00
Televideo 970, 14" green screen, 132 column, European	TVI-970	1259.00
Zenith 29 terminal, VT52 compatible, detatchable keyboard	ZTH-Z29	765.00
ADDS Viewpoint A1 detatchable keyboard	ADD-VP1	585.00
ADDS Viewpoint A2, xy cursor	ADD-VP2	615.00

APPLE

$1595



Apple II/E Starter System includes CPU, Apple brand green monitor, disk drive, 80 column card, and stand.

Advanced Busness Tech. 13 Key Pad	ABT-13B	$109
Calif. Computer 7710A Async. Serial Interface	CCS-7710	125
Calif. Computer 7710B same but for modem	CCS-7710B	125
Calif. Computer 7114A 12K PROM module	CCS-7114	99
Calif. Computer 7720A parallel interface	CCS-7720	99
Calif. Computer 7724A Calandar/clock modual	CCS-7724	99
Calif. Computer 7729A Centronics interface	CCS-7729	99
Calif. Computer 7740A programmable timer	CCS-7740	99
California Digital 16K card for standard Apple II	CAL-A16	39
Hayes Micromodem II for Apple II	HYS-MM2	279
Kensington Micro, System saver fan	KEN-SF1	75
Kraft Corp. Apple Joystick	KFT-JY2	49
Microsoft Softcard with CP/M; Z-80	MSF-SFTCD	239
Mountain Computer "The Clock"	MTN-TCLK	225
Mountain Computer Super talker SD200	MTN-STLK	149
Mountain Computer AD/DA 16 input, 8 bit	MTN-ADDA	269
Mountain Computer ROM Plus with keybb. filter	MTN-RMF	169
Mountain Computer ROM writer/socket	MTN-ROMW	139
Orange Micro "GRAPPLER" parallel interface	OMS-G2	135
Sorrento Valley 8" controller double side D/D	SVA223	395
TEAC 5¼" disk drive for Apple II	TEA-A2	269
Vista Vision 80; 80 column card for std.Apple II	VSA-VIS80	289
Vista 8" disk controller double side D/D	VSA-A800	489

XEROX WORD PROCESSING KEYBOARD $69



Back by popular demand, our best selling word processing keyboard. 77 key keyboard manufactured by Micro switch for the Xerox Corporation. Hall effect keys for the utmost reliability.

This keyboard outputs a seven bit ASCII code along with an eighth bit that allows most keys to shift and double function as special characters. Extra large Tab and Return keys similiar in layout to the IBM Selectric.

17 keys are illuminated for special word processing functions. Two BCD thumbwheel switches are also featured. MIC-77X 6 lbs. Custom enclosure option available.

5¼" WINCHESTER CONTROLLER

DUAL PROCESSOR CPU BOARD

octagon

8/16 CPU cuts the price of a dual processor system in half! A single board now contains an 8 MHz 8088, 4 MHz Z80, 2 serial ports, interupt controller, and dual density floppy disk controller. CP/M 2.2, CP/M 86, MS/DOS, PC/DOS, as well as UNIX is available.

The serial ports are fully software programmable with baud rates up to 19,200. The 8088 CPU can be jumpered for either 8 or 5 MHz operation. A socket is provided for the 8087 math processor chip. Intel 8272 disk controller is incorporated, controlling both 8" and 5¼" floppy disks simultaniously. The interupt controller is an 8259 that can accept interupts from on board as well as from the VI0-VI7 lines on the buss. **$795.00**

Octagon Hard Disk Controller Board features the new Western Digital "Error Correcting" Winchester Controller chip set. This optimized chip set and a data separator, designed exclusively for Octagon, assures you extremely high data integrity.

The Octagon Hard Disk Controller can control up to four 5¼" Winchester drives simultaniously. The Board also includes an 8 bit Centronics printer port, and two fully programmable serial ports with baud rates to 19,200. **$475.00**

S-100 BOARDS

16 BIT MICROPROCESSORS

Octagon dual CPU 8088 Z80 & disk controller	OCT-88Z80	795.00
Godbout 8086 8087 microcomputer 16 bit	GBT-8687	495.00
Godbout dual processor 8085 8088 8 16 bit	GBT-8588	359.00
Lomas Data Systems Lighting One 8 MHz	LDM-8086	429.00

SINGLE BOARD COMPUTERS

Insight EQ-4 128K 4 serial not S-100	INS-EQ4	595.00
Advanced Digital Floppy & 64K	AMD-Z80	750.00
Teletek System master NEC765 floppy 64K	TEL-SM1	895.00
Teletek FDC-1 single board without memory	TEL-FDC1	675.00

8 BIT MICROPROCESSORS

Godbout Z80 24 bit extended add	GBT-Z80	250.00
California Computer Z80 microprocessor	CCS-2810	275.00
Tarbell Z80 with two RS232 ports	TAR-Z80	339.00

FLOPPY DISK CONTROLLERS

Godbout Disk 1 double density NEC765	GBT-DSK1	395.00
California Computer Systems 2422A with CPM	CCS-2422	339.00
Morrow Disk Jockey II with CPM 2.2	MDS-DJ2	350.00
Morrow Disk Jockey I with CPM, single density	MDS-DJ1	225.00
Tarbell Electronics double density controller	TAR-DDC	419.00
Tarbell Electronics single density controller	TAR-SDC	279.00
Fulcrum DMA OmniDisk I O to hard disk	FCM	389.00

CPM OPERATING SYSTEM

Digital Research CP M 3.0 8" single density	DRC-CpM30	249.00
Godbout CPM 2.2 for Disk 1	GBT-CpM22	159.00
Godbout CPM86 for 8088 and 8086	GBT-CpM86	265.00
Tarbell Electronics CPM 2.2	TAR-CpM22	159.00

HARD DISK CONTROLLERS

Octagon hard disk controller with error correcting	OCT-HD1	475.00
Godbout Disk 2 8" & 14" hard disk	GBT-DSK2	569.00
Godbout Disk 3 for 5¼" Winchesters	GBT-DSK3	Nov.
Morrow Designs controller for 5¼" Winchester	MDS-W506	495.00
Western Digital new WD-1001 (not S-100)	WDI-1001	495.00

EPROM BOARDS

Inner Access EPROM Bd. programs 27128's	IAC-P100	465.00
Digital Research read only PROM board 32K	DGR-P32	119.00

STATIC MEMORY BOARDS

Godbout Ram 16 64K 16 bit data transfer	GBT-R16	459.00
Godbout Ram 17 64K 8 bit 24 bit extend add	GBT-R17	359.00
Godbout Ram 21 128K byte 8 16 transfer	GBT-R21	859.00
Fulcrum OmniRam 8 16 transfer bank select	FCM-R816	395.00
California Digital 2116 8 bit only 16K byte	CCS-2116	249.00

DYNAMIC MEMORY BOARDS

California Digital 256K byte expand to 1 Meg	CAL-D256	495.00
California Computer 2066 64K bank select	CCS-2066	295.00

INTERFACE BOARDS

Godbout Interfacer I 2 serial ports	GBT-133A	239.00
Godbout Interfacer II 1 serial 3 parallel ports	GBT-150A	269.00
Godbout Interfacer III with 5 serial ports	GBT-135A	495.00
Godbout Interfacer III with 8 serial ports	GBT-138A	585.00
Godbout Interfacer IV 3 serial 2 parallel	GBT-187A	329.00
California Computer 2710 4 serial ports	CCS-2710	279.00
California Computer 2719 2 serial & 2 parallel	CCS-2719	295.00
California Computer 2720 4 port parallel	CCS-2720	219.00
California Computer 2830 6 port serial board	CCS-2830	429.00
Morrow Designs Multiboard 3 serial 2 parallel	MDS-MTL1	319.00

SPECIAL FUNCTION BOARDS

Hayes S-100 Micromodem 300 baud FCC reg	HYS-M100	325.00
QT Computer clock calendar bat back up	QTC-CC100	139.00
Godbout System support board 4K EPROM	GBT-SYS1	350.00
Godbout System support board with 9511 math	GBT-S9511	539.00
Dual Systems 4 channel 12 bit D A converter	DSC-AOM12	619.00
Dual System 12 bit resolution 32 channel A D	DSC-AIM12	629.00
Mullins Opto-Isolator controls 8 channels	MUL-ICB10	179.00
Mullins extender board with logic & test probe	MUL-TB1	79.00
I O Technology wire wrap prototype board	IOT-W100	49.00
Artec Electronics wire wrap prototype board	ART-WW100	25.00
Artec Electronics general purpose solder board	ART-GP100	25.00

MAINFRAMES & MOTHER BOARDS

Eclipse Data industrial stainless steel 18 slot	EDP-100	695.00
Godbout Enclosure 2 20 slot active termination	GBT-MF2D	675.00
California Computer 2200 12 slot with term	CCS-2200	479.00
California Digital 18 slot mother board	CAL-MB18	35.00
Godbout 12 slot mother board assembled	GBT-MB12	149.00

CP/M SOFTWARE

AdaSoft CP/M	ADA-445C	395.00
D-Base II	ASH-015C	429.00
Wordstar	MPR-187C	309.00
Mailmerge	MPR-392C	169.00
Spellstar	MPR-429C	169.00
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Macro 80	MSF-187C	139.00
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Pascal Plus	DGR-004C	429.00
CP/M 86	DGR-186C	239.00
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Additional Software available for Apple, IBM/PC and Atari. Please telephone for price and availability.



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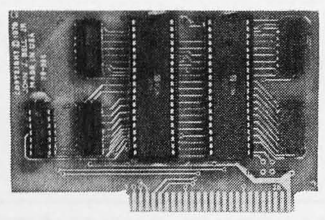
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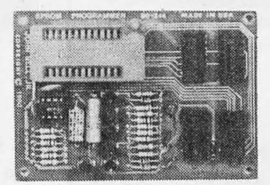
PERIPHERALS FOR THE APPLE II

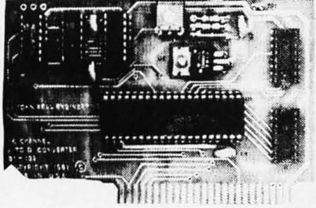
look for low cost–high quality inter-faces for the APPLE II



6522 APPLE II INTERFACE. This interface plugs directly into slot 1 through 7 in the APPLE II or the APPLE IIe. It provides four 8 bit bi-directional I/O ports, four 16 bit timer/counters, and handshaking. Four 16 pin dip sockets provide easy connections to peripheral devices. This board is also used to run the JBE EPROM Programmer. Order part # 79-295A assm. **$69.95** or # 79-295B bare board **$29.95**

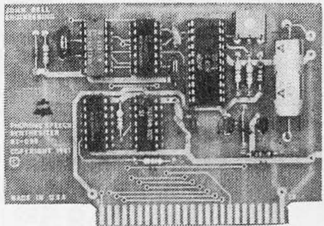
EPROM PROGRAMMER. Programs 5 volt 2716's, 2516's, and 2532's. It interfaces to the 6522 interface with 4 ribbon cables. A Textool zero insertion force socket is used for the EPROM. Complete documentation for reading and writing. Cables available separately. Order part # 80-244A assm. **$49.95** or # 80-244B bare board **29.95** and set of 4 cables 2 ft. long **$17.00**





A-D CONVERTER. 16 Channel A-D plugs into your APPLE II or APPLE IIe. The 16 inputs are high impedance, 0 to 5 volt range, 8 bit resolution. Conversion time is less than 100 us per channel. Two 16 pin dip sockets are used for input. Order part # 81-132A assm. **$89.95** or # 81-132B bare board **$29.95**

SPEECH SYNTHESIZER. This board uses the VOTRAX SC-01 Phoneme Synthesizer chip. The on board audio amp connects directly to an 8 ohm speaker. A disk with a text to speech program is included. Order part #81-088 **$129.95**



To order: Send check or money order. Add 6.5% tax in California. Add 5% shipping for orders less than $100 or 3% for orders over $100 or 10% outside U.S.A. Phone orders: We accept Visa or MC. Add $2.00 for C.O.D. Will Call Hours 9am to 4pm.

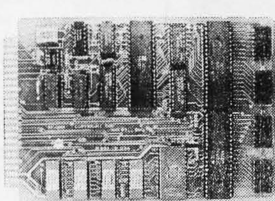
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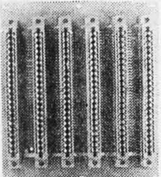
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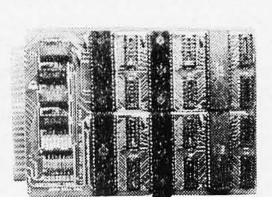
look for low cost–high quality indus-trial computers



SLIM MICROCOMPUTER. This 6502 based 4.5″ × 6.5″ computer has the same 44 pin bus as the AIM computer. It has 2K RAM, 2K or 4K EPROM, and four 8 bit parallel I/O ports (two 6522's). The clock is 1 MHz crystal controlled and has power on reset. This board was designed for control and is ideal for personal and OEM use. This computer can be expanded with the peripherals listed below. Order part # 81-260A assm. **$199.95** or #81-260B bare board **$39.95**

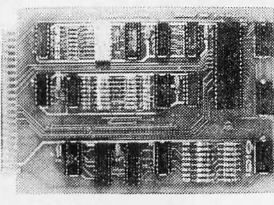


SIX SLOT MOTHER BOARD. This board has 6 44 pin edge connectors connected in parallel. The card spacing is .750″. It will mount in VECTOR card cages. Order part # 81-320A assm. **$99.95** or # 81-320B bare board **$49.95.**



12 PORT PARALLEL I/O. This board has six 6522 VIA's. This is a total of 96 I/O lines. Each of the 12 8 bit ports also has 2 handshake lines. Order part # 82-036A assm. **$169.95** or # 82-036B bare board **$49.95**

RAM EPROM MEMORY (32K). This board has 16 24 pin sockets that will accept 2716 EPROM's or 6116 RAM's to total 32K bytes. The memory is mapped from 0 to 7FFF. The first 2K (0-7FF) can be disabled with a jumper to allow for the 2K of RAM on the SLIM computer. Order part # 81-330A assm. w/o memory **$99.95** or # 81-330B bare board **$49.95**



ANALOG I/O INTERFACE. This board has 16 analog inputs and 2 analog outputs. The inputs are 8 bit (256 steps), 0-5 volt, high impedance with a conversion time of 200us per channel. The outputs are R-2R ladders (R = 15K) driven between 0 and 5 volts and are 8 bit (256 steps) also. Order part # 81-292A assm. **$199.95** or #81-292B bare board **$49.95**

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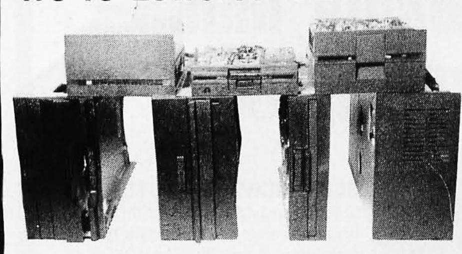
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★LAST MINUTE SPECIAL!!! Buy any Winchester hard disk drive above and get a Western Digital hard disk interface board AT COST! .... *ONLY* 295.00!

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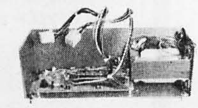
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★ Supports CP/M®, MP/M®, OASIS

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★ Includes CP/M® 2.2
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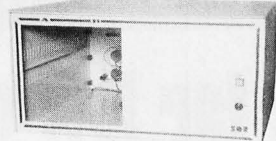
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ON THE ORIGINAL S-100 MOD

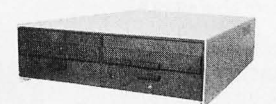
For engineers, hobbiests, and anyone who wants to save a bundle, the S1-MOD is the answer. Full regulated power to run up to four floppy disks coupled with a mamoth S-100 power supply and 12 slot bus, makes the S1-MOD an exceptional computer base. Single board design means no wiring from the power suppply to the motherboard. This eliminates all ground loop problems associated with other brands of mainframes who are forced to use termination. The S1-MOD is being offered this month with a matching S-100-12 cabinet. Fan cooled, fused, with reset and keylock the cabinet is also enamel painted and silk screened. Four A.C. outlets are provided for peripheral hookup and plenty of cutouts available for RS-232, centronics + others. Our regular $225.00 price for the S1-MOD and 250.00 price for our 12 slot cabinet is being SLASHED!

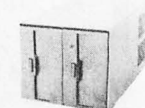
SPECIFICATIONS:

Regulated	Unregulated
+5V @ 5A	+8V @ 30A
+24V @ 3A	+16V @ 6A
–5V @ 1A	–16V @ 6A

Don't settle for those cheap 6 slot immitations you've seen elsewhere in this mag. OWN THE BEST! XOR S-1 MOD and S-100-12 Cabinet **$395.00**

DUAL DRIVE SUBSYSTEMS





HORIZONTAL OR VERTICAL
Fully Assembled and Tested Units
ONE YEAR P+L WARRANTY
On Shugart and Mitsubishi Subsystems

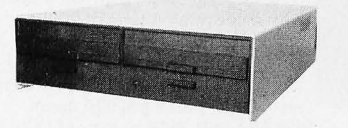
w/two Misubishi DS/DD Assem. + Tested 2.4 Meg $1170.00
w/two Shugart 801R SS/DD Assem. + Tested 1.2 Meg 975.00
w/two Shugart 851R DS/DD Assem. + Tested 2.4 Meg 1225.00
w/two Siemans 120-8 SS/DD Assem. + Tested 1.2 Meg 675.00
w/two Qume DT-8 DS/DD Assem. + Tested 2.4 Meg 1250.00
Cabinet Assem. & Tested w/Power Supply and Accs. 235.00
Cabinet Top and Bottom with Mounting Hardware .... Only 69.50

All cabinets A & T and subsystems include all AC/DC wiring and 50 pin data cable except the horizontal model which includes the internal 50 pin cable and requires an external 50 pin cable part #C-6000-01 .... $ 25.00

5¼" Subsystems – Cabinet – Power Supply – Drives – Cables
w/two 48TPI SS/DD includes all cables Assem. + Tested 495.00
w/two 48TPI DS/DD includes all cables Assem. + Tested 595.00
w/two 96TPI DS/DD includes all cables Assem. + Tested 695.00

CUSTOMER SERVICE HOTLINE 1 - (714) 898-5525

DRIVE CABINET DEALS



STILL ON SALE!
On assembled and tested cabinets.

One year parts and labor on these dual drive cabinets, complete with power supplies, A.C. and D.C. cables, 50 pin data cables (vertical only) and complete mounting hardware.

8" horizontal cabinet assembled and tested #S-1000-05 SALE $199.00
50 pin data cable for horizontal cabinet #C-6000-01 .... $ 25.00
8" vertical cabinet complete w/50 pin data cable #S-1000-13 SALE $199.00
5¼" vertical cabinet complete with 34 pin data cable #S-1000-20 SALE $129.00

BARE CABINETS!

Horizontal or vertical types, we'll even supply mounting hardware. Cabinets are enamel painted a beautiful tan texture and have mounting holes available for fan, drives, A.C. cable, power supply, etc.

Horizontal 8" Empty w/Hardware .. **$59.95**
Vertical 8" Empty w/Hardware **$55.00**

★ The fifty-five dollar ★ 8" Power Supply is Back!

Specifications:
For 2 8" Floppys
+5 V.D.C. @ 4 Amps
+24 V.D.C. @ 3 Amps
–5 V.D.C. @ 1 Amp

Perfect for do it yourself applications. Will run at 120V/50 Hz or 230V/50 Hz. All power supplies include D.C. cables and schematic.

8" Power Supply #U-1000-02 .... **$55.00**
SS/DD A.C. Harness #C-6000-37 .... **$ 7.50**
DS/DD A.C. Harness #C-6000-38 .... **$ 7.50**

PERIPHERAL SPECIALS

XOR 500 TERMINAL SALE!
$495⁰⁰

XOR 500: A new video display terminal featuring ★ Screen tilt ★ Detached keyboard ★ 9 cursor control keys ★ 5 function keys ★ 7 screen attributes ★ 25th status line ★ 50-19.2K baud ★ Column + filed tab ★ and more ★ All these features with a full 6 month warranty make this terminal the best buy on the market. RS-232 cable not included.

XOR 500 #T-1000-15 .... **$495.00**



OKIDATA ML92

Okidata Microline: New versatility, correspondence quality printing and speed make the ML92 and ML93 the best printer values in their categories. Both printers provide multi-speed print modes; bi-directional high speed mode with short line seeking logic at 160cps, emphasized and enhanced mode printing at 80cps, and high resolution correspondence quality printing at 40cps. Dot-addressable graphics is standard. Both serial and parallel models are available and **BOTH prices include** full tractor assembly at no extra charge.

#M-2000-10 parallel w/tractor ... **$599.00**
#M-2000-83 serial w/tractor **$699.00**

5¼" MITSUBISHI



5¼" Half Height Floppys. 48 or 96 T.P.I. These double sided, double density drives will hold .5 and 1 megabytes unformatted — full one year parts and labor warranty. The 48 T.P.I. drives are perfect for I.B.M. P.C. add-ons!

#D-1000-34 DS/DD 48 T.P.I. Thinline .. **$295.00**
#D-1000-32 DS/DD 96 T.P.I. Thinline .. **$315.00**

PMMI S-100 MODEMS

2 models are now available. The highly popular MM103 which is Bell 103A @ 300 baud, also runs at 600 baud, and the new modem from PMMI which is Bell 103A and 212 compatible at 300 and 1200 baud, auto answer auto dial IEEE 696 standard. If software is a problem, we've got it! Designed specifically for the PMMI

#M-2000-45 300-600 baud **$349.00**
#M-2000-44 300-1200 baud **$595.00**
#B-1001-16 Crosstalk Software ... **$150.00**





★ MADE IN USA ★ BUY FACTORY DIRECT ★

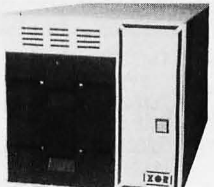
TERMS: We accept VISA/MC, prepay, check or money order. Please allow personal check two weeks to clear before shipment. $5.00 handling charge on all orders under $50.00. 15% Restocking Fee. All orders shipped via U.P.S. unless otherwise specified. All UPS C.O.D. orders over $100.00 require a Cashiers Check. ★ Our products carry a full 6 months parts and labor warranty excluding drives, printers and terminals which carry the full O.E.M. factory warranty. PRICES SUBJECT TO CHANGE WITHOUT NOTICE.

★ EAST ★ 11 Edison Drive, New Lenox, Illinois 60451
★ WEST ★ 15392 Assembly Lane, Huntington Beach, CA 92649

CUSTOM COMPUTER SYSTEMS by XOR

Why do companies like I.B.M. Corp. Atari Corp., Mattel Elec., Kennedy Space Center, Edwards A.F.B., Motorola Corp., Raytheon, and Pacific Technology buy product by mail from us? Maybe it's our full 1 year parts and labor warranty on all XOR O.E.M. products. It could be our state of the art technology, or even the factory direct sales and service. We think it's our custom computer systems with over 1000 possible configurations. If you don't see it advertised, call us today, chances are we CAN custom build the system YOU need.

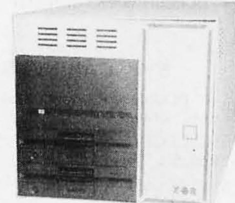
★ MICRO MANAGERS: POWERFUL, PORTABLE, AND AFFORDABLE ★



Don't be fooled by the system's small portable size. A full 64K of memory with an industry standard S-100 bus. Includes CP/M 2.2 and many utilities on two disks. Add on a hard disk when you need more storage. "The software and hardware that comes with each 5¼" system, is ready to run a pair of 8" single or double sided floppies, just plug in the 50 pin data cable to the system — many other configurations are available."

5¼" Z-80A 64K CP/M System

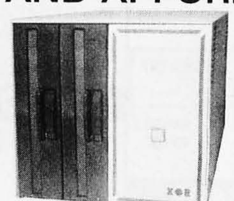
- ★ Dual Floppy 375K SS/DD 40 Track #S-1000-86 ...... $1445.00
- ★ Dual Floppy 750K DS/DD 40 Track #S-1000-87 ...... $1595.00
- ★ Dual Floppy 1.5 Meg DS/DD 80 Track #S-1000-88 ... $1645.00
- ★ System Chassis (No boards, drives, CP/M) #S-1000-84 $ 425.00



Inexpensive but powerful, small enough for portability, these mini hard disk systems have a special XOR interface to the S-100 bus that leaves an S-100 slot open for expandability. Choose from 5, 10, and 16 megabyte sizes (6.5, 12, + 20 megabyte unformatted.) Includes CP/M operating system. One year parts and labor warranty. Includes software and controller for 8" floppys.

5¼" Hard Disk with ½ Height Floppys

- ★ 5 Meg Hard Disk w/375 Floppy #S-1000-81 .... $2195.00
- ★ 5 Meg Hard Disk w/750K Floppy #S-1000-90 .... $2345.00
- ★ 10 Meg Hard Disk w/2 1.5M Floppy #S-1000-92 .... $2795.00
- ★ 16 Meg Hard Disk w/2 1.5M Floppy #S-1000-93 .... $2895.00

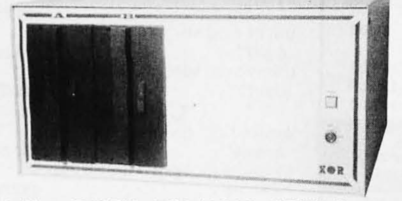


Our most popular computer features a 4 slot S-100 bus and 8" industry standard format. Reads and writes the IBM 3740 format as well as any byte size sector. Expandable? Yes, add a hard disk or cartridge subsystem when your data base grows. You've probably seen some "look-a-like" S-100 4-slot systems lately, but they just don't measure up the **XOR 8" Micro Manager**

2.4 Meg DS/DD 8" CP/M System

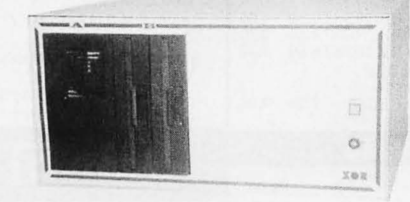
- ★ System w/Dual SS/DD 1.2 Meg #S-1000-40 .... $1795.00
- ★ System w/Dual DS/DD 2.4 Meg #S-1000-39 .... $1995.00
- ★ System w/NO Drives (Includes CP/M) #S-1000-71 ... $1195.00
- ★ System Chassis (No boards, drives, CP/M) #S-1000-70 $ 395.00

★ THE BASIC PROFESSIONAL FLOPPY, HARD DISK AND TAPE BACKUP ★



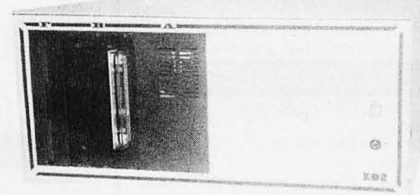
2.4 Meg DS/DD 64K Z-80A CP/M System

This "Industry Standard" computer features a 12 slot motherboard, 30 amp power supply, 2 serial RS-232 ports, centronics parallel port and CP/M software. The XOR disk controller included, will read and write the I.B.M. 3740 format (8" CP/M standard) as well as R/W single on double sided, single or double density, and any byte/size sector. One year parts and labor on the complete system. #S-1000-36 .... $2345.00



20 Meg Winchester w/2.4 Meg Floppys

For the serious professional this system features the famous S-100-12 cabinet with XOR's S1-MOD 12-slot motherboard. The Quantum hard disk has two 10 Meg platters (A: and B:). One platter can be "backed-up" on another. 2/DS/DD 1.2 floppys are used for software entry, copies, and back-up. One year parts and labor. #S-1000-63 .... $5275.00



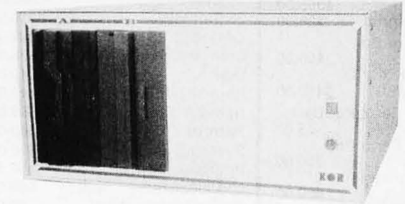
20M H.D. with 17M Tape and 1.2M Floppy

Backup your priceless data on this full 17 megabyte tape drive and be able to pip files between any of the three peripherals for total versatility. Boot CP/M from hard disk or floppy, change tapes for archival storage. Reads and writes the IBM 3740 Format (8" CPM standard). #S-1000-69 .... $6390.00.
Above system 40 megabyte hard disk #S-1000-82 .... $7240.00

CP/M 3.0 U.S. MICRO SALES SOFTWARE GIVEAWAY! CP/M 3.0

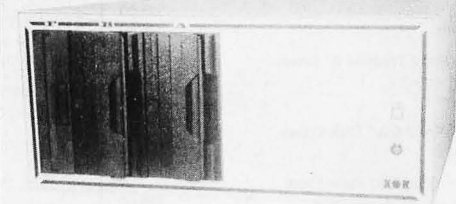
FREE Order any system below and get all of the following software and manuals absolutely **FREE! CP/M Operating System, Perfect Writer, Perfect Speller, Perfect Mailer, Perfect Calc,** AND an eight module business accounting package by **BUSINESSMASTER** INCLUDING: **A/R order entry, A/P purchase orders, G/L, Payroll, Mailing List, Fixed Asset Accounting, Inventory** (RAW), and **inventory regular goods.** AND multi-user systems also include Digital Research's **MP/M** and **Link-80** software. .... **$1685.00 value.** **FREE**

★ THE OFFICE MASTERS! REMOVABLE CARTRIDGE DISK SYSTEMS ★



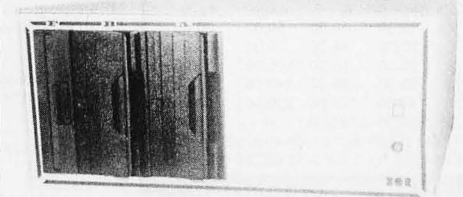
10 Meg Cartridge Disk And 1.2 Meg Floppy

An office system at an almost unbelievable price when you consider the bundle of applications software that comes with the system. Ten megabytes of formatted storage on a removable cartridge disk allows unlimited storage space with extra 10 Meg cartridges available at $50.00 each. With the speed and reliability of a hard disk and removability of a floppy this office master is the choice. #S-1000-74 .... $3695.00



TWO 10 Meg Removable and DS/DD Floppy

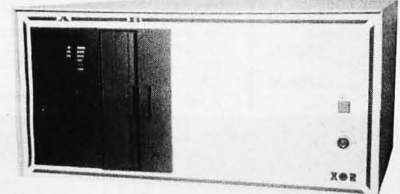
Destined to be our #1 seller and no one else makes anything like it. A true state-of-the-art system with virtually no-limit to storage capacities in 10 Meg removable cartridges. Backup problems? Get high speed backup from cartridge to cartridge, ten megabytes worth, in 6 minutes! HINT: We don't use "PIP." Future technology here today. #S-100-76 ... $4595.00



Multi-User Cartridge Disk System

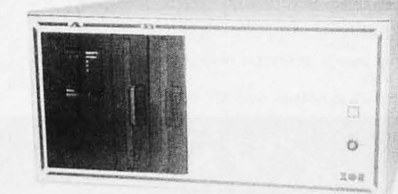
Four users and two 10 megabyte removable cartridge disks may be just what you want to automate your office or small business, with all the software packages you'll ever need. A multi-user version of the system at left, these users can be up to 100 feet away from each other. Most any terminal will work with the user ports. #S-1000-80 .... $5825.00

★ THE BUSINESS PROFESSIONALS: HARD DISK MULTI-USER SYSTEMS ★



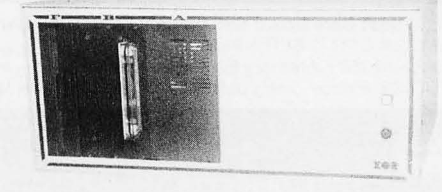
2 User Hard Disk System

A twenty meg hard disk (2 platter) with a DS/DD 1.2 Meg floppy disk makes this a perfect system for a small business. Two user allows dual access to the system files with each station up to 100 feet apart! Includes above software. Full one year parts and labor. #S-1000-61 .... $5495.00



40 Meg Hard Disk 4 User System

A must for a growing business! Two DS/DD floppys (2.4 Meg) for data backup and copy with a 4 platter 40 Meg hard disk four user capability to automate the whole front office. You can even designate a 10 Meg platter to each user! Same warranty as all our products — (configurable from 2 to 7 users) #S-1000-60 $7295



7 User 85 Meg w/17 Meg Backup

Now it's available, the automated business system to run even those large companies! 7 separate users tied into one professional host system. If 85 Meg isn't enough, we can put together as much as three hundred and forty megabytes! Full 17 Meg tape backup insures archival storage of valuable data #S-1000-98 $9595.00

Circle 488 on inquiry card.

LET US CUT YOU A DEAL!

MINIMUM SHIPPING $3.00 - NO SURCHARGE ON VISA/MASTERCARD

1-800-545-2633 - Continental U.S.

DISK DRIVES

SHUGART

5¼" SA400 (35-TR) 160K	150.00
5¼" SA400L (40 TR) 190 K	175.00
5¼" SA455L (40 TR) 320 K ½ HGT	235.00
8" SA801R(SS/DD) 1.2 MG	359.00
8" SA851R(DS/DD) 2.4 MG	479.00

QUME

5¼" 142 (40TR) 320 K ½ HGT	240.00
8" DT8 (842)	490.00

MITSUBISHI

5¼" M-4853 ½ size *96 TPI same as TM 100-4*	410.00
5¼" M-4854 ½ size *1.6 MG w/8" electronics formats same as IBM 1 & 2D 8" std*	439.00

8" M-2894-63 (110V) 399.00
STD 8" DS/DD 1.2 MG

M-2894-63(SS/DD) 220V	449.00
8" M-2996-63 *Thinline 8" DS/DD 1.2 MG*	439.00

REMEX

5¼" RFD 480-DS/DD (For IBM-PC)	235.00

TANDON

5¼" TM100-1 SS/DD 160K	150.00
5¼" TM100-2A FOR IBM-PC *DS/DD (320 K)*	239.00
8" TM848-2 (DS/DD) 1.2 MG	450.00

PERTEC

5¼" FD200-5 160 K *SS/DD 40TR*	139.00
5¼" FD250-5 320 K *DS/DD 40TR*	195.00

SIEMAN'S

8" FD100-8 (SS/DD) 110V 801 R	179.00
8" FD100-8 (SS/DD) 220V Compatible	199.00

MPI

5¼" B-51 *40TR SS/DD* 180 K	145.00

DISKETTE STORAGE

ADVANCE ACCESS

AA-5¼ (Holds 82 Disks)	17.00
AA-8 (Holds 82 Disks)	26.00

Smoked Plexiglass Disk Tubs

LIBRARY CASES

CAS-5¼"	2.50
CAS-8"	3.00
Color Burst (Pack of 5)	12.00

Colors Available; color burst asst., beige, black, blue, red, gray

DATA CABLES

8"DSC 88-2SKT-for 2-8" drvs w/skt. conn.	20.00
5¼"DSC55-2SKT-for 1-5¼" dvs w/skt. conn.	20.00
RS232MM-5' (male to male)	19.00
IBM to PAR	32.00
Osborne to PAR	32.00
Kaypro to PAR	32.00
OKI-Data Serial	24.00

E-PROM ERASERS

QUV-T8/1 (hobby)	49.95
QUV-T8/2 (Industrial version)	68.95
QUV-T8/2 (w/timer & safety switch)	97.50

CONNECTORS

RS232 Connectors
SOLDER TYPE

DB25P	2.50
DB25S	3.00
DB25 Hood	1.00
S-100 Connectors	10 for 25.00
DE9P	2.00

FLAT RIBBON TYPE

IDC25P	6.25
IDC25S	6.60
IDC25 Hood	1.60

SOCKET
Qty. 100

IDC10SKT	1.90	1.00	IDC26SKT	3.50	1.60
IDC16SKT	2.50	1.20	IDC34SKT	4.50	2.20
IDC20SKT	2.75	1.30	IDC50SKT	6.50	3.20

CARD EDGE
Qty. 100

CEC26	5.00	2.70	CEC50	7.25	4.90
CEC34	6.00	3.50			

MODEMS

Anchor	89.00
Hayes Smart 300	199.00
Hayes Smart 1200	499.00
Multi-Tech MT 212 AD (1200/300)	499.00
Novation J-Cat 300	119.00
Novation Apple Cat	269.00
SSM AMC -300 (For Apple) Auto Dial	259.00
U.S. Robotics 212A Auto Dial	469.00

DISK DRIVE CABINETS

8" CABINETS

8" DDC88V28 w/PS vertical for 2-8" drives	300.00
8" DDC88T-1 w/PS vertical-for 2 or 4-8" thinline drives	300.00
8" DDC88T-2 w/PS vertical for 2 8" thinline drives	225.00
8" DDC8H w/PS horizontal for 1 ea. 8" drive	249.00
8" DDC8V w/PS vertical for 1 8" drive	249.00
8" DDC88H w/PS horizontal for 2-8" drives	300.00

5¼" CABINETS

5¼" DDC5H w/PS horizontal-for 1-5¼" drive	59.00
5¼" DDC5V w/PS vertical-for 1 ea. 5¼" drive	65.00
5¼" DDC55V w/PS vertical-for 2-5¼ drives	89.00

DISK SUB ASSEMBLY

OUR BEST BUY'S

8" SUB ASSEMBLY

DDS + 0 2EA SS/DD Siemens FD100-8 Drives w/Cabinet	595.00
DDS + 2 2EA DS/DD Mitsubishi M2894-63 w/cabinet	1,075.00
DDS + 4 2EA DS/DD 8" Thinline Drives w/Cabinet	1,150.00

Specify—Vertical or Horizontal Cabinet

5¼" SUB ASSEMBLY

DDS + 5 1EA SS/DD Disk Drive	200.00
DDS + 6 2EA SS/DD Disk Drive	369.00

PARTS

TR1602B	2.50 ea.
2114L2	$1.50 ea.
TMS2532	$5.95 ea.
2716 (5V)	$3.95 ea.
TMS2716 (5 + 12V)	$3.95 ea.
TMS2732	$4.95 ea.
TMS4164 (200NS)	$5.95 ea.
TMS116-4 (200NS)	$4.75 ea.

MANY OTHERS IN STOCK

VIDEO DISPLAY MONITORS

GREEN

BMC 12AU (15 MHZ) 80 Col/12"	80.00
Dynax GM 120 (20 MHZ) Hi-Res/80 Col/12"	129.00
Sanyo DM 2112 (15 MHZ) 64 Col/12"	80.00
Sakata SC-1000 (18 MHZ) 80 Col/12"	119.00
USI PI-1 (20 MHZ) Hi-Res/9"	129.00
USI PI-2 (20 MHZ) Hi-Res/12"	139.00
Zenith ZM121 (18 MHZ) Hi-Res/80 Col/12"	94.00

AMBER

Dynax AM121 (20 MHZ) Hi-Res/80 Col/12"	139.00
USI PI-4 (20 MHZ) Hi-Res/80 Col/9"	139.00
USI PI-3 (20 MHZ) Hi-Res/80 Col/12"	149.00

COLOR

Amdek I-12" Composite (For Apple)	260.00
Amdek II-12"-RGB (For IBM-PC) w/audio	469.00
Amdek I + Composite w/audio	289.00
BMC 9191-12" Composite (For Apple)	255.00
Princeton HX-12-RGB (For IBM-PC)	489.00
Sakata SC-100-13" Composite (For All)	260.00
Sakata SC-200-RGB (For All)	489.00

DISKETTES

COLOR CODE YOUR FILES

Diskettes by 3M with lifetime warranty, 5 colors. Prices are for package of 10.

5¼" Sgl side/dbl den	21.00/10
5¼" Dbl side/dbl den	28.00/10
5¼" 10 sector	22.00/10
5¼" 16 sector	22.00/10
8" Sgl side/dbl den	29.00/10
8" Dbl side/dbl den	39.00/10

S-100 PRODUCTS

CARD CAGES/MOTHER BOARDS

**IEEE-696-No termination required*

Slots	Bare Bd	A + T	w/card cage	bare card cage
4	15.00	40.00	60.00	20.00
6	20.00	48.00	70.00	22.00
8	25.00	69.00	100.00	31.00
12	30.00	99.00	140.00	41.00
18	45.00	150.00	200.00	50.00
22	60.00	185.00	—	75.00

All card cages will accommodate a 4" fan
Add $20.00 for 1 fan-Add $30.00 for 2 fans

CLOCK/CALENDAR

S-100 Clock/Calendar by QT/ Computime CCS-BB Bare Bd.	45.00
CCS-A Assembled and Tested	**$95.00**

MAINFRAMES

For 2 Standard 8" Drives

MF + DD6 (6 slot M/B)	530.00
MF + DD8 (8 slot M/B)	595.00
MF + DD12 (12 slot M/B)	625.00

For 2 Thinline 8" Drives

IMF + DD6C (Cadillac version)	500.00
IMF + DD6F (Ford version)	350.00

For 2-5¼" Disk Drives

MF + MD12 (12 slot M/B)	560.00

Standard Plain Front

MF + 12 (12 slot M/B)	469.00
MF + 22 (22 slot M/B)	530.00

All mainframes except IMF + DD6F have EMI filter, 2 AC outlets, 15 ea. DB25, 2 ea. 50 pin, 2 ea. 34 pin, 1 ea. Centronic cutouts, power supply for 8" MF
(−5V1A/ + 5V6A/ + 8V16A/ ± 16V3A/ + 24V6A)

CPU/MEM/I/O

QTC-SBC 2/4BB 1 ser 1 par CPU	$50.00
QTC-SBC 2/4 A A + T	$265.00
QTC-Z + 80 BB 1 serial	$28.00
QTC-EXP + III Bare Bd. (dynamic)	$65.00
QTC-EXP + III 64K A + T (64K/256K or 1 MEG)	$450.00
I/O Tech I/O + 2 Ser 3 Par Bare Bd.	75.00
I/O Tech I/O + 2 Ser 3 Par A & T	300.00
I/O Tech ADA Converter Bd	400.00
I/O Tech Dual GP1B Interface Bd	575.00
I/O Tech S-Ram 128K Static 16 bit	795.00

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Ram 21-128K	900.00
Ram 16	400.00
System Support I	350.00
Interface/4R MSP	350.00
CPU 8086/8087	599.00
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SDS-CPM/B105-cp/m for SBC 100 w/BIOS	$150.00
SDS-Turbodos-Multi-user for master & slaves	$645.00

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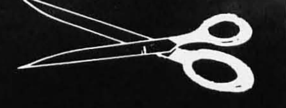
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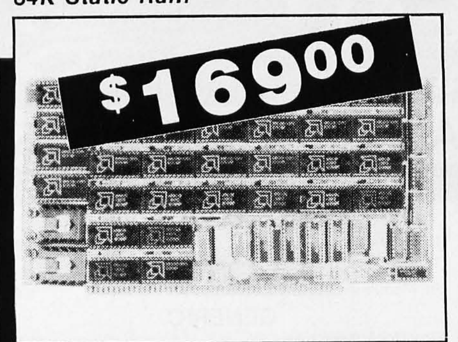
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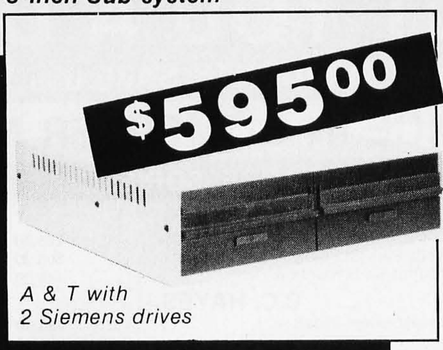
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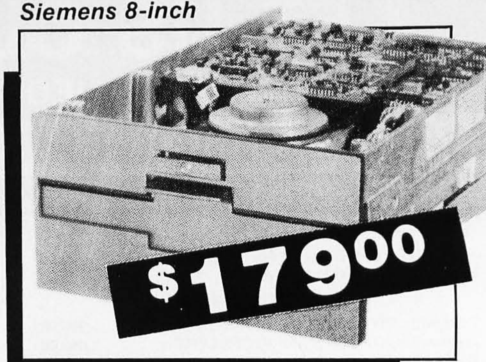


8-inch Sub-system



A & T with
2 Siemens drives





JADE Computer Products

PRICE

8-inch Slimline Sub-systems

Dual Slimline Sub-systems - JADE

Handsome vertical cabinet with scratch resistant baked enamel finish, proportionally balanced air flow system, quiet cooling fan, rugged dual drive power supply, power cables, power switch, line cord, fuse holder, cooling fan, all necessary hardware to mount two 8 inch slimline disk drives. Does not include signal cable

Dual 8 inch Slimline Cabinet

END-000820	*Bare cabinet*	$59.95
END-000822	*A & T w/o drives*	$164.95

Dual 8 inch Slimline Sub-systems

END-000843	*Kit w/2 SS DD drives*	$869.00
END-000844	*A & T w/2 SS DD drives*	$879.00
END-000845	*Kit w/2 DS DD drives*	$1060.00
END-000846	*A & T w/2 DS DD drives*	$1099.00

Dual Disk Sub-systems

Disk Sub-systems - JADE

Handsome metal cabinet with proportionally balanced air flow system, rugged dual drive power cable kit, power switch, line cord, fuse holder, cooling fan, nevermar rubber feet, all necessary hardware to mount two 8 inch disk drives, power supply, and fan, does not include signal cable

Dual 8" Sub-Assembly Cabinet

END-000420	*Bare cabinet*	$49.95
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8" Sub-Systems—Single Sided, Double Density

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8" Sub-Systems—Double Sided, Double Density

END-000426	*Kit w/2 Qume DT-8s*	$1229.00
END-000427	*A & T w/2 Qume D-8s*	$1249.00
END-000436	*Kit w/2 Shugart SA-851 Rs*	$1199.00
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Disk Drive Power Supply

Sufficient current to power up to three 8-inch disk drives

PART NO	DESCRIPTION	1-9	10-24	24-99
PSD-206A	*8" power supply*	89.95	79.95	69.95

8-inch Disk Drives

Siemens FDD 100-8 Single sided, double density
MSF-201120 $179.00 ea 2 for $175.00 ea

Shugart SA 801R Single sided, double density
MSF-10801R $355.00 ea 2 for $349.00 ea

Shugart SA-10851R Double sided, double density
MSF-10851R $459.00 ea 2 for $455.00 ea

Qume DT-8 Double sided, double density
MSF-750080 $479.00 ea 2 for $459.00 ea

Tandon TM 848-1 Single sided, double density thin-line
MSF-558481 $369.00 ea 2 for $359.00 ea

Tandon TM 848-2 Double sided, double density thin-line
MSF-558482 $439.00 ea 2 for $435.00 ea

NEC FD1165 Double sided, double density thin-line
MSF-851165 $450.00 ea 2 for $440.00 ea

NEC FD1164 Single sided, double density thin line
MSF-851164 $360.00 2 for $350 ea

5¼-inch Disk Drives

Tandon TM 100-1 Single sided, double density 48 TPI
MSM-551001 $225.00 ea 2 for $195.00 ea

Shugart SA 400L Single sided, double density 40 track
MSM-104000 $209.00 ea 2 for $199.95 ea

Tandon TM 100-2 Double sided, double density 48 TPI
MSM-551002 $229.00 ea 2 for $225.00 ea

MPI B52 Double sided, double density, 48 TPI can be substituted for CDC
MSM-155200 $275.00 ea 2 for $270.00 ea

MPI B51 Single sided, double density 48 TPI
MSM-155100 $209.00 ea 2 for $199.00 ea

MPI B91 Single sided, Quad density 96 TPI
MSM-155300 $285.00 ea 2 for $275.00 ea

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MSM-155400 $400 ea 2 for $590.00 ea

5¼ inch Cabinets with Power Supply

END-000216	*Signal cab w/power supply*	$69.95
END-000226	*Dual cab w/power supply*	$85.00

Disk Tubs

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Clear Plexiglass storage boxes for up to 75 diskettes

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MMA-508	*Holds 50 8" diskettes*	$29.95

S-100 Memory Boards

64 Static Ram - JADE

Uses new 2K x 8 static RAMs, fully supports IEEE 696 24 bit extended addressing, 200ns RAMs, lower 32K or entire board phantomable, 2716 EPROMs may be subbed for RAMs, any 2K segment of upper 8K may be disabled, low power typically less than 500ma

MEM-99152B	*Bare board*	$49.95
MEM-99152K	*Kit less RAM*	$89.95
MEM-32152K	*32K kit*	$169.00
MEM-56152K	*56K kit*	$225.00
MEM-64152K	*64K kit*	$265.00
Assembled & Tested		add $30.00

EXPANDORAM III

SD Systems new ExpandoRAM III is a high density S-100 memory board utilizing the new 64K x 1 dynamic RAM chips. It allows memory sizes of 64K, 128K or 256K all on a single S-100 board.

MEM-65064A	*64K*	$398.95
MEM-65128A	*128K*	$464.95
MEM-65192A	*192K*	$524.95
MEM-65256A	*256K*	$598.95

ExpandoRAM IV - SD Systems NEW!

State-of-the-Art; full compliance with IEEE 696, 256K using 64K RAM chips. Up to 1024K using 256K RAM chips, parity check, error detection and correction optional. Supports both 8 and 16 bit data transfers. One year factory warranty

MEM-66256	*ExpandoRAM IV w/parity*	$975.95
MEM-67256	*ExpandoRAM IV w/EDC*	$1675.95



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ISOBAR

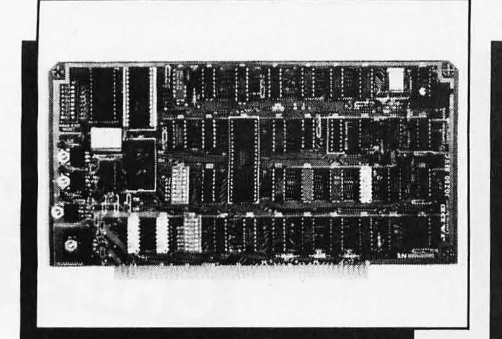
The ISOBAR looks like a standard multi-outlet power strip, but contains surge suppression circuitry and built-in noise filters, plus a 15 amp circuit breaker

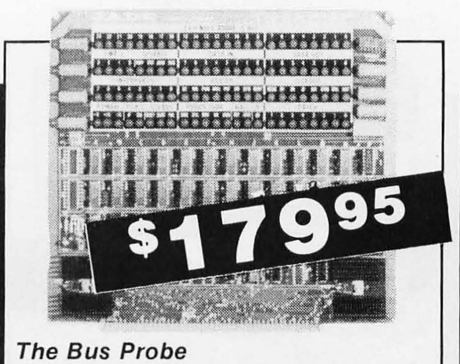
EME-115105	*4 receptacle*	$49.95
EME-115100	*8 receptacle*	$69.95

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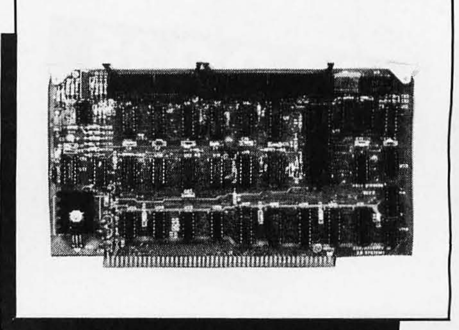
The Big Z





The Bus Probe





BREAKTHROUGH!

S-100 I/O Boards

The Bus Probe
Inexpensive S-100 diagnostic analyzer

TSX-200B	*Bare board*	$59.95
TSX-200K	*Kit*	$179.95
TSX-200A	*A & T*	$199.95

I/O-4 - SSM MICROCOMPUTER
Two serial I/O ports plus two parallel I/O ports

IOI-1010A	*A & T*	$245.00

I/O-5 - SSM MICROCOMPUTER
Two serial & three parallel ports, 110-19.2K baud

IOI-1015A	*A & T*	$289.00

Interfacer 4 - COMPUPRO
Three serial, one parallel, one centronics parallel

IOI-1840A	*A & T*	$389.95
IOI-1830C	*CSC*	$495.00

I/O-8 - SD Systems **NEW!**
Full compliance with IEEE 696 standards, operates as a Bus Slave. Available with 8 Async parts or 4 Async and 4 Async ports, up to 1 Megabit/sec in synchronous mode. Real time clock with battery back-up. One year factory warranty

IOI-1510A	*8 Async ports*	$589.95
IOI-1520A	*4 Sync/4 Async*	$669.95

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Ultra-violet Eprom Erasers
Inexpensive erasers for industry or home

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XME-3200	*Logical Devices*	$49.95

S-100 Eprom Boards

PB-1 - SSM MICROCOMPUTER
2708, 2716 EPROM board with on-board programmer

MEM-99510K	*Kit w/manual*	$154.95
MEM-99510A	*A & T w/manual*	$219.00

Prom-100 - SD Systems
2708, 2716, 2732 EPROM programmer with software

MEM-99520A	*A & T with software*	$219.95

S-100 CPU Boards

The BIG Z — Jade
2 or 4 MHz switachable Z-80 CPU board with serial I/O accommodates 2708, 2716, or 2732 EPROM, baud rates from 75 to 9600.

CPU-30200B	*Bare board w/manual*	$35.00
CPU-30201K	*Kit w/manual*	$179.00
CPU-30201A	*A & T*	$199.00

SBC-200 - SD Systems
4 MHz Z-80A CPU with serial & parallel I/O, 1K RAM, 8K ROM space, monitor PROM included.

CPC-30200A	*A & T*	$298.95

CPU-Z - COMPUPRO
2 or 4 MHz Z80A cpu, 24 bit addressing

CPU-30500A	*2/4 MHz A & T*	$279.95
CPU-30500C	*3/6 MHz CSC*	$374.95

8085/8088 - COMPUPRO
Both 8 & 16 bit CPUs standard 8 bit S-100 bus, up to 8 MHz, accesses 16 MegaBytes of memory

CPU-20510A	*6 MHz A & T*	$389.95
CPU-20510C	*6/8 MHz CSC*	$497.95

SBC 300 - SD Systems **NEW!**
Self-contained S-100 Z80 microcomputer, 4/6 MHz, 64K RAM with parity; 2 to 16K of PROM, 24 bit addressing, fully complies with IEEE 696 standards. It can function as a permanent Bus Master *or* as Slave. Two fully programmable serial channels with handshaking; full SASI port. One year factory warranty

CPC-30304A	*SBC 300, 4 MHz, A & T*	$619.95
CPC-30306A	*SBC 300, 6 MHz, A & T*	$689.95

S-100 Motherboards

ISO Bus - JADE
Silent, simple and on sale—a better motherboard

6 Slot (5¼" x 8⅝")

MBS-061B	*Bare board*	$22.95
MBS-061K	*Kit*	$39.95
MBS-061A	*A & T*	$49.95

12 Slot (9¾" x 8⅝")

MBS-121B	*Bare board*	$34.95
MBS-121K	*Kit*	$69.95
MBS-121A	*A & T*	$89.95

18 Slot (14½" x 8⅝")

MBS-181b	*Bare board*	$54.95
MBS-181K	*Kit*	$99.95
MBS-181A	*A & T*	$139.95

S-100 Disk Controllers

VERSAFLOPPY II - SD Systems
Double density disk controller for any combination of 5¼" and 8" single or double sided, analog phase-locked loop data seperator, vectored interrupts. CP/M 2.2 & Oasis compatible control/diagnostic software PROM included.

IOD-1160A	*A & T with Prom*	$344.95
SFC-55009047F	*CP/M 3.0 with VF-II*	$80.00

2422 Disk Controller - CCS
5¼" or 8" double density disk controller with on-board boot loader ROM, FREE! CP/M 2.2 & manual set

IOD-1300A	*A & T with CP/M 2.2*	$338.00

Double D - JADE
High reliability double density disk controller with on-board Z-80A, auxilliary printer port, IEEE S-100 can function in multi-user interrupt driven bus

IOD-1200B	*Bare board & hdwr man*	$59.95
IOD-1200K	*Kit w/hdwr & sftwr man*	$299.95
IOD-1200A	*A & T w/hdwr & sftwr man*	$325.00
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IOD-1170A	*Versafloppy II/696 A & T*	$349.95
SFC-55009157F	*8" banked CP/M 3.0**	**$75.00
SFC-55009157M	*5¼" banked CP/M 3.0**	**$75.00
SFC-55009159F	*8" unbanked CP/M 3.0**	**$75.00
SFC-55009159M	*5¼" unbanked CP/M 3.0**	**$75.00

***configured for Versafloppy II/696 & SBC 300**
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Versafloppy III - SD Systems **NEW!**
Winchester *and* floppy controller in a single board! Full compliance with IEEE 696 standards, controls up to three floppy drives and three 5¼" Winchester drives. Data may be transfered under DMA *or* programmed I/O control. One year factory warranty

IOD-1180A	*Versafloppy III A & T*	$759.95
SFC-55009257F	*8" banked CP/M 3.0**	**$129.00
SFC-55009257M	*5¼" banked CP/M 3.0**	**$129.00
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SYA-1520A *Apple fan* ______ $59.95

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80 column x 24 line video card for Apple II addressable 25th status line, normal/inverse or high/low video, 128 ASCII characters, upper and lower case, 7 x 9 dot matrix with true descenders, CP/M, Pascal & Fortran compatible, 50/60 Hz, 40/60 column selection from keyboard. Best 80 column card!

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IOV-2455A *Preboot disk for above* ______ $24.95

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IOM-5610A *300 baud Deluxe* ______ $149.95
IOM-5620A *1200/300 baud Deluxe* ______ $369.95
IOM-5650A *300 baud for Osborne* ______ $119.95
IOM-5630A *300 baud card for IBM* ______ $199.95

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IOM-5500A *Smartmodem 1200* ______ $475.00
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IOK-1500A *Hayes Cronograph* ______ $199.00
IOM-1100A *Micromodem 100* ______ $349.00
IOM-2010A *Micromodem II* ______ $259.00

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103/212 Smart Cat & 103 Smart Cat, 1200 & 300 baud, built-in dialer, auto re-dial if busy, auto answer/disconnect, direct connect, LED readout displays mode analog/digital loopback self tests, usable with multi-line phones

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IOM-5261A *Novation J-CAT* ______ $119.00

Wire Wrap Sockets

PART NO	NO OF PINS	1-9	10-24	25-99	100-249
SKW-0832	8	.54	.49	.44	.40
SKW-1432	14	.64	.54	.49	.46
SKW-1632	16	.74	.64	.51	.50
SKW-1832	18	.89	.78	.74	.69
SKW-2032	20	1.09	.94	.90	.86
SKW-2232	22	1.24	1.14	1.04	.93
SKW-2432	24	1.24	1.14	1.04	.95
SKW-2832	28	1.29	1.44	1.34	1.24
SKW-4032	40	1.99	1.75	1.59	1.39

Low Profile Sockets

PART NO	NO OF PINS	1-9	10-24	25-99	100-249
SKLA-0801	8	.24	.17	.09	.07
SKL-1401	14	.24	.17	.14	.13
SKL-1601	16	.24	.19	.17	.15
SKL-1801	18	.29	.24	.21	.17
SKL-2001	20	.29	.24	.22	.19
SKL-2201	22	.34	.24	.24	.21
SKL-2401	24	.39	.29	.29	.23
SKL-2801	28	.44	.34	.34	.27
SKL-4001	40	.49	.39 .44	.41	.39

IDC Card Edge Type Connectors

PART NO	DESCRIPTION	1-9	10-24	25-99	100-249
CNE-5102020	20 pin	2.70	2.45	3.25	2.45
CNE-5102620	26 pin	3.45	3.15	3.45	2.65
CNE-5103420	34 pin	4.45	4.15	3.45	3.45
CNE-5104020	40 pin	5.35	4.95	4.45	4.15
CNE-5105020	50 pin	6.45	5.95	5.85	4.85

IDC- Pin-Type Connectors

PART NO	DESCRIPTION	1-9	10-24	25-99	100-249
CNF-62200	20 pin	2.70	2.45	1.80	1.55
CNF-62260	26 pin	3.45	3.15	2.35	1.95
CNF-62340	34 pin	4.45	4.15	3.05	2.55
CNF-62400	40 pin	5.35	4.95	3.80	2.95
CNF-62500	50 pin	6.45	5.95	4.55	3.75

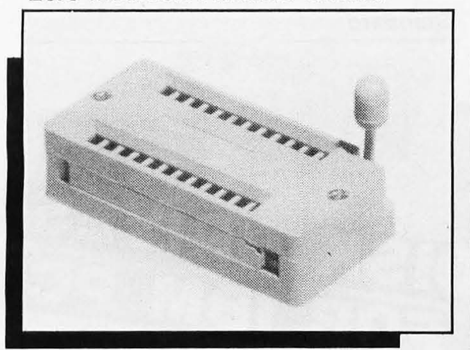
Right Angle PC Mount 50 Pin Header

PART NO	DESCRIPTION	1-9	10-24	25-99	100-249
CNM-222501	50 pin	4.25	3.55	2.95	2.40

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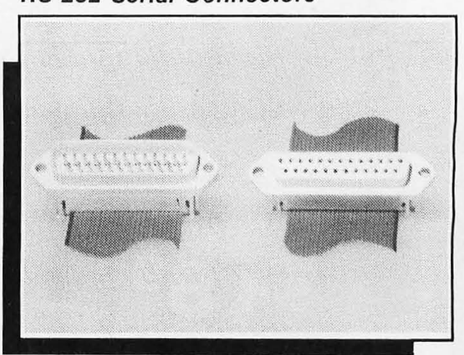
Zero Insertion Pressure Socket



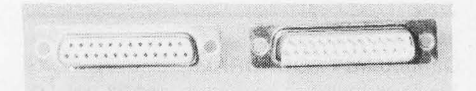
Printer Connector



RS 232 Serial Connectors



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DB 25P, DB 25S, DB 25C

CND-1250 *RS-232 connector set* $7.50

P=male/plug S=female/socket C=cover/hood

PART NO	DESCRIPTION	1-9	10-24	25-99	100-249
CND-1091	DE 9P	1.95	1.55	1.40	1.30
CND-1092	DE 9S	2.70	2.35	2.00	1.80
CND-1094	DE 9C	1.45	1.20	1.05	.95
CND-1151	DA 15P	2.55	2.25	1.95	1.75
CND-1154	DA 15S	3.35	2.95	2.65	2.45
CND-1152	DA 15C	1.45	1.20	1.05	.95
CND-1251	DB 25P	2.45	2.35	2.20	1.90
CND-1252	DB 25S	3.20	3.05	3.00	2.95
CND-1253	2pc cover	1.45	1.20	1.05	.95
CND-1254	1pc cover	1.60	1.35	1.20	1.10
CND-2251	DB 25P PC MT	3.75	3.25	3.15	2.95
CND-2252	DB 25S PC MT	4.35	3.95	3.75	3.40
CND-9001	screw lock	.95	.75	.65	.55
CND-1371	DE 37P	4.45	3.95	3.55	3.25
CND-1372	DE 37S	5.95	5.35	4.75	4.25
CND-1374	DE 37C	1.70	1.45	1.30	1.15
CND-1501	DD 50P	5.90	5.30	4.70	4.20
CND-1502	DD 50S	7.90	7.15	6.45	5.95
CND-1504	DD 50C	1.95	1.70	1.45	1.25

Zero Insertion Force Sockets

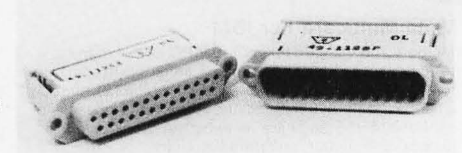
PART NO	DESCRIPTION	1-9	10-24	25-99	100-249
CNZ-1116	16 pin	5.95	5.45	4.95	4.45
CNZ-1124	24 pin	7.45	6.95	5.95	5.45
CNZ-1140	40 pin	9.95	8.95	7.95	6.45

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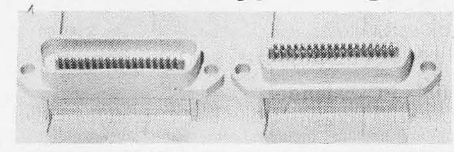
PART NO	DESCRIPTION	PRICE
ICP-2764	64K EPROM	5.90
ICP-2732	32K EPROM	4.75
ICP-2716	16K EPROM	3.95
ICP-2716-1	16K Eprom 350ns	5.95
ICP-2758	8K Eprom	4.95
ICP-2708	8K Eprom	3.95
ICR-4164/20	64K Dynamic 200NS	5.75
ICR-4164/15	64K Dynamic 150NS	6.25
ICR-4116/20	16K Dynamic Ram 200ns	1.95
ICR-4116/15	16K Dynamic Ram 150ns	2.25
ICR-6116/20	2K x 8 Static 200NS	4.90

Insulation Displacement Connectors



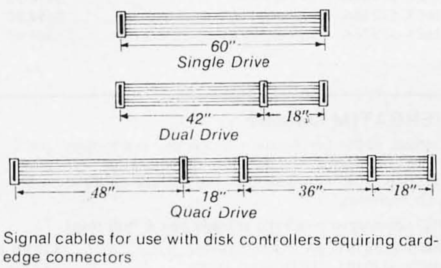
PART NO	DESCRIPTION	1-9	10-24	25-99	100-249
CND-5251	DB 25S	6.55	5.95	5.15	4.45
CND-5252	DB 25P	5.95	5.35	4.75	3.95

Centronics Type Plugs



PART NO	DESCRIPTION	1-9	10-24	25-99	100-249
CNX-236	male IDC	9.90	8.95	7.95	6.95
CNX-336	female IDC	9.45	8.75	7.75	6.75
CNX-136	male solder	8.95	7.45	5.95	5.20

Disk Drive Signal Cables



Signal cables for use with disk controllers requiring card-edge connectors

WCA-5030A *Dual 8" drive cable* $32.50
WCA-3431A *Dual 5¼" drive cable* $29.95
WCA-5050A *Quad 8" drive cable* $39.95

Signal cables for use with disk controllers requiring pin-type connectors

WCA-3430A *Dual 5¼" drive cable* $29.95
WCA-5036A *Dual 8" drive cable* $32.50
WCA-5052A *Quad 8" drive cable* $39.95

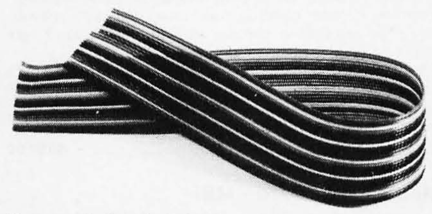
RS232 Cables

Standard RS 232 Cables

All cables are 9 conductor, with pins 1 through 8 and pin 20 connected to DB25-type connectors. Fully assembled and tested including covers. Shipping weight 1 lb

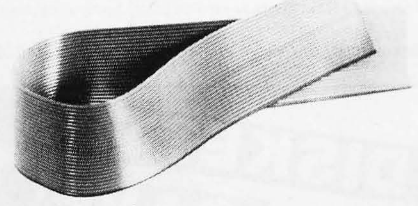
WCA-1020A *Male to male, 10' long* $24.95
WCA-1021A *Male to male, 20' long* $29.95
WCA-1022A *Male to female, 10' long* $29.95

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28 gauge, 7 strand Color Coded

PART NO	CONDUCTORS	PRICE
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WCR-141C010	14	3.80
WCR-161C010	16	4.00
WCR-201C010	20	5.00
WCR-241C010	24	6.15
WCR-261C010	26	6.45
WCR-341C010	34	8.30
WCR-401C010	40	10.00
WCR-501C010	50	13.00



28 gauge, 7 strand Grey

PART NO	CONDUCTORS	PRICE
WCR-101N010	10	4.00
WCR-141N010	14	5.20
WCR-161N010	16	5.75
WCR-201N010	20	7.00
WCR-241N010	24	8.50
WCR-261N010	26	9.00
WCR-341N010	34	11.75
WCR-401N010	40	16.00
WCR-501N010	50	17.50

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120 cps (82, 83), 200 cps (84), industry standard printers, serial and parallel interfaces, true lower case descenders, handles single-sheet as well as fan fold paper

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PRA-43181 *2K serial board* **$129.95**
PRA-43086 *IBM PC ROMS for 92* **$59.95**
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PRA-43080 *Extra ribbon (2)* **$9.95**

Starwriter F10

High speed letter quality printer. 40 cps daisywheel, sleek low-profile design (6-inch high). Extensive built-in word processing functions, up to 15-inch paper width Uses standard Diablo style printwheels, low noise for office environments. Centronics or serial interface versions available

PRD-22010 *F10/parallel* **$1195.00**

NEW! TTX - Compact Daisywheel

Low-profile, contemporary design, & requires 20% to 50% less desk space than most other daisywheel printers. Other features include dual interface (RS232 & centronics parallel), built-in adjustable pinfeed forms guide, & compatibility with Wordstar print control commands, including underline, bold print, super & sub-script etc

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Economical Daisywheel printer with 200 words per minute (18 cps), full 15-inch platen, Diablo 630 protocal, 10, 12, 15 pitch or proportional printing. Very quiet, very reliable; a bargain in the under $1000.00 letter quality printer market

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PRD-52002 *Serial, List 995.00* **$775.00**
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PRA-11100 *Tractor option* **$119.95**
PRA-99700 *Cut sheet feeder* **$199.95**

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Desk top printer stand and paper rack. Fits all printers

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Free standing deluxe printer stand with chrome plated paper catch. Universal mounting for all 15-inch carriage dot matrix and letter quality printers. List Price $129.95 31 lbs

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Apple and IBM compatible RGB color. Now you can have the quality of an RGB color monitor for your Apple III, IBM, or Apple II in your choice of medium or super high resolution. Both of these units feature an 18MHz bandwidth linear video amplifier for limitless color variety and best picture quality in text and graphics.
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VDC-821230 *RGB-Vision III* **$649.00**
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VDA-821210 *IBM PC cable* **19.00**
VDA-821220 *Apple III cable* **$19.00**
VDA-821200 *Apple II card & cable* **$129.00**
VDA-821230 *Apple IIe & 80 Column Card* **$179.00**

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15 MHz, 40 or 80 column

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2102L-2	1024 x 1 (250ns) (LP)	1.45
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2112	256 x 4 (450ns)	2.95
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TMS4044-3	4096 x 1 (300ns)	3.95
TMS4044-2	4096 x 1 (200ns)	4.45
MK4118	1024 x 8 (250ns)	9.90
TMM2016-200	2048 x 8 (200ns)	4.10
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HM6116-3	2048 x 8 (150ns) (cmos)	4.90
HM6116-2	2048 x 8 (120ns) (cmos)	8.90
HM6116LP-4	2048 x 8 (200ns) (cmos)(LP)	5.90
HM6116LP-3	2048 x 8 (150ns) (cmos)(LP)	6.90
HM6116LP-2	2048 x 8 (120ns) (cmos)(LP)	9.95
Z-6132	4096 x 8 (300ns) (Qstat)	33.95

LP = Low Power   Qstat = Quasi-Static

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TMS4027	4096 x 1 (250ns)	1.95
UPD411	4096 x 1 (300ns)	2.95
MM5280	4096 x 1 (300ns)	2.95
MK4108	8192 x 1 (200ns)	1.90
MM5298	8192 x 1 (250ns)	1.80
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4116-250	16384 x 1(250ns)	8/10.95
4116-200	16384 x 1(200ns)	8/11.95
4116-150	16384 x 1(150ns)	8/13.95
4116-120	16384 x 1(120ns)	8/28.95
2118	16384 x 1(150ns) (5v)	4.90
4164-200	65536 x 1(200ns) (5v)	5.90
4164-150	65536 x 1(150ns) (5v)	6.90

5V = single 5 volt supply

EPROMS

1702	256 x 8 (1us)	4.45
2708	1024 x 8 (450ns)	3.90
2758	1024 x 8 (450ns) (5v)	5.90
2716	2048 x 8 (450ns) (5v)	3.90
2716-1	2048 x 8 (350ns) (5v)	5.90
TMS2516	2048 x 8 (450ns) (5v)	5.45
TMS2716	2048 x 8 (450ns)	7.90
TMS2532	4096 x 8 (450ns) (5v)	5.90
2732	4096 x 8 (450ns) (5v)	4.90
2732-250	4096 x 8 (250ns) (5v)	8.90
2732-200	4096 x 8 (200ns) (5v)	10.95
2764	8192 x 8 (450ns) (5v)	9.90
2764-250	8192 x 8 (250ns) (5v)	13.95
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TMS2564	8192 x 8 (450ns) (5v)	16.95
MC68764	8192 x 8 (450ns) (5v)(24 pin)	38.95
27128	16384 x 8Call	Call

5v = Single 5 Volt Supply

74LS00

74LS00	.23	74LS173	.68
74LS01	.24	74LS174	.54
74LS02	.24	74LS175	.54
74LS03	.24	74LS181	2.10
74LS04	.23	74LS189	8.90
74LS05	.24	74LS190	.88
74LS08	.27	74LS191	.88
74LS09	.28	74LS192	.78
74LS10	.24	74LS193	.78
74LS11	.34	74LS194	.68
74LS12	.34	74LS195	.68
74LS13	.44	74LS196	.78
74LS14	.58	74LS197	.78
74LS15	.34	74LS221	.88
74LS20	.24	74LS240	.94
74LS21	.28	74LS241	.98
74LS22	.24	74LS242	.98
74LS26	.28	74LS243	.98
74LS27	.28	74LS244	1.25
74LS28	.34	74LS245	1.45
74LS30	.24	74LS247	.74
74LS32	.28	74LS248	.98
74LS33	.54	74LS249	.98
74LS37	.34	74LS251	.58
74LS38	.34	74LS253	.58
74LS40	.24	74LS257	.58
74LS42	.48	74LS258	.58
74LS47	.74	74LS259	2.70
74LS48	.74	74LS260	.58
74LS49	.74	74LS266	.54
74LS51	.24	74LS273	1.45
74LS54	.28	74LS275	3.30
74LS55	.28	74LS279	.48
74LS63	1.20	74LS280	1.95
74LS73	.38	74LS283	.68
74LS74	.34	74LS290	.88
74LS75	.38	74LS293	.88
74LS76	.38	74LS295	.98
74LS78	.48	74LS298	.88
74LS83	.59	74LS299	1.70
74LS85	.68	74LS323	3.45
74LS86	.38	74LS324	1.70
74LS90	.54	74LS352	1.25
74LS91	.88	74LS353	1.25

74LS92	.54	74LS363	1.30
74LS93	.54	74LS364	1.90
74LS95	.74	74LS365	.48
74LS96	.88	74LS366	.48
74LS107	.38	74LS367	.44
74LS109	.38	74LS368	.44
74LS112	.38	74LS373	1.35
74LS113	.38	74LS374	1.35
74LS114	.38	74LS377	1.35
74LS122	.44	74LS378	1.13
74LS123	.78	74LS379	1.30
74LS124	2.85	74LS385	1.85
74LS125	.48	74LS386	.44
74LS126	.48	74LS390	1.15
74LS132	.58	74LS393	1.15
74LS133	.58	74LS395	1.15
74LS136	.38	74LS399	1.45
74LS137	.98	74LS424	2.90
74LS138	.54	74LS447	.36
74LS139	.54	74LS490	1.90
74LS145	1.15	74LS624	3.95
74LS147	2.45	74LS640	2.15
74LS148	1.30	74LS645	2.15
74LS151	.54	74LS668	1.65
74LS153	.54	74LS669	1.85
74LS154	1.85	74LS670	1.45
74LS155	.68	74LS674	9.60
74LS156	.68	74LS682	3.15
74LS157	.64	74LS683	3.15
74LS158	.58	74LS684	3.15
74LS160	.68	74LS685	3.15
74LS161	.64	74LS688	2.35
74LS162	.68	74LS689	3.15
74LS163	.64	74LS783	23.95
74LS164	.68	81LS95	1.45
74LS165	.94	81LS96	1.45
74LS166	1.90	81LS97	1.45
74LS168	1.70	81LS98	1.45
74LS169	1.70	25LS2521	2.75
74LS170	1.45	25LS2569	4.20

6500

1MHZ

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6505	8.90
6507	9.90
6520	4.30
6522	7.90
6532	9.90
6545	21.50
6551	10.85

2 MHZ

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6522A	9.90
6532A	10.95
6545A	26.95
6551A	10.95

3 MHZ

6502B	13.95

6800

68000	58.95
6800	3.90
6802	7.90
6808	12.90
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6809	10.95
6810	2.90
6820	4.30
6821	3.20
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6843	33.95
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6850	3.20
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6862	10.95
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68B00	9.95
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68B09	28.95
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8203	38.95
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8214	3.80
8216	1.70
8224	2.20
8226	1.75
8228	3.45
8237	18.95
8237-5	20.95
8238	4.45
8243	4.40
8250	9.95
8251	4.45
8253	6.90
8253-5	7.90
8255	4.45
8255-5	5.20
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8257-5	8.90
8259	6.85
8259-5	7.45
8271	38.95
8272	38.95
8275	28.95
8279	8.90
8279-5	9.00
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8283	6.45
8284	5.45
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78MO5C	.34	7908T	.84
7808T	.74	7912T	.84
7812T	.74	7915T	.84
7815T	.74	7924T	.84
7824T	.74	7905K	1.44
7805K	1.34	7912K	1.44
7812K	1.34	7915K	1.44
7815K	1.34	7924K	1.44
7824K	1.34	79L05	.78
78L05	.68	79L12	.78
78L12	.68	79L15	.78
78L15	.68	LM323K	4.90
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C,T = TO-220 K = TO-3 L = TO-92

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18 pin ST	.19	.17
20 pin ST	.28	.26
22 pin ST	.29	.26
24 pin ST	.29	.26
28 pin ST	.39	.31
40 pin ST	.48	.38
64 pin ST	4.20	call

ST = SOLDERTAIL

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16 pin WW	.68	.57
18 pin WW	.98	.89
20 pin WW	1.04	.97
22 pin WW	1.34	1.23
24 pin WW	1.44	1.30
28 pin WW	1.64	1.44
40 pin WW	1.94	1.75

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3.579535	3.90
4.0	3.90
5.0	3.90
5.0688	3.90
5.185	3.90
5.7143	3.90
6.0	3.90
6.144	3.90
6.5536	3.90
8.0	3.90
10.0	3.90
10.738635	3.90
14.31818	3.90
15.0	3.90
16.0	3.90
17.430	3.90
18.0	3.90
18.432	3.90
20.0	3.90
22.1184	3.90
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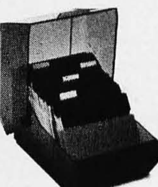
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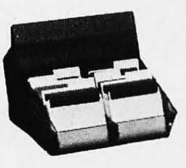
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SN7421N	14	.35
SN7422N	14	.45
SN7423N	16	.59
SN7425N	14	.29
SN7426N	14	.29
SN7427N	14	.25
SN7428N	14	.49
SN7430N	14	.25
SN7432N	14	.29
SN7437N	14	.25
SN7438N	14	.29
SN7439N	14	.59
SN7440N	14	.19
SN7441N	16	.89
SN7442N	16	.45
SN7443N	16	.99
SN7444N	16	.99
SN7445N	16	.69
SN7446N	16	.69
SN7447N	16	.69
SN7448N	16	.69
SN7450N	14	.19
SN7451N	14	.19
SN7453N	14	.19
SN7454N	14	.19
SN7459A	14	.25
SN7460N	14	.19
SN7470N	14	.29

Part No.	**Pins	Price
SN7472N	14	.29
SN7473N	14	.35
SN7474N	14	.35
SN7475N	16	.45
SN7476N	16	.35
SN7479N	14	4.95
SN7480N	14	.69
SN7482N	14	1.19
SN7483N	16	.59
SN7485N	16	.59
SN7486N	14	.35
SN7489N	16	2.25
SN7490N	14	.39
SN7491N	14	.59
SN7492N	14	.39
SN7493N	14	.39
SN7494N	14	.69
SN7495N	14	.49
SN7496N	16	.49
SN7497N	16	2.75
SN74100N	24	1.49
SN74104N	14	.89
SN74105N	14	.89
SN74107N	**14**	**.29**
SN74109N	**16**	**.39**
SN74116N	24	1.49
SN74121N	14	.39
SN74122N	14	.55
SN74123N	16	.49
SN74125N	14	.45
SN74126N	14	.45
SN74132N	14	.49
SN74136N	14	.69
SN74141N	16	.69
SN74142N	16	2.95
SN74143N	24	2.95
SN74144N	24	2.95
SN74145N	16	.59
SN74147N	16	1.49
SN74148N	16	1.19
SN74150N	24	1.19
SN74151N	16	.59
SN74152N	14	.59
SN74153N	16	.59
SN74154N	24	1.25
SN74155N	16	.59

Part No.	**Pins	Price
SN74156N	16	.59
SN74157N	**16**	**.59**
SN74160N	16	.69
SN74161N	16	.69
SN74162N	16	.69
SN74163N	16	.69
SN74164N	14	.69
SN74165N	16	.69
SN74166N	16	.89
SN74167N	16	2.79
SN74170N	16	1.29
SN74172N	24	4.95
SN74173N	16	.69
SN74174N	16	.69
SN74175N	16	.69
SN74176N	14	.69
SN74177N	14	.69
SN74179N	16	1.49
SN74180N	14	.69
SN74181N	24	1.95
SN74182N	16	.89
SN74184N	16	1.95
SN74185N	16	1.95
SN74190N	16	.69
SN74191N	16	.69
SN74192N	16	.69
SN74193N	16	.69
SN74194N	16	.69
SN74195N	16	.69
SN74196N	14	.89
SN74197N	14	.89
SN74198N	24	1.19
SN74199N	24	1.19
SN74221N	16	1.19
SN74251N	16	.79
SN74276N	20	1.95
SN74279N	16	.79
SN74283N	16	1.49
SN74284N	16	2.95
SN74285N	16	2.95
SN74365N	16	.55
SN74366N	16	.55
SN74367N	16	.55
SN74368N	16	.55
SN74390N	16	1.49
SN74393N	14	1.49

74LS

74LS00	14	.25
74LS01	14	.25
74LS02	14	.25
74LS03	14	.25
74LS04	14	.29
74LS05	14	.29
74LS08	14	.29
74LS09	14	.29
74LS10	14	.29
74LS11	14	.35
74LS12	14	.35
74LS13	14	.39
74LS14	14	.59
74LS15	14	.35
74LS20	14	.29
74LS21	14	.29
74LS22	**14**	**.29**
74LS26	14	.29
74LS27	14	.29
74LS28	14	.35
74LS30	14	.29
74LS32	14	.35
74LS33	14	.55
74LS37	14	.35
74LS38	14	.35
74LS40	14	.29
74LS42	16	.55
74LS47	16	.75
74LS48	16	.75
74LS49	14	.75
74LS51	14	.25
74LS54	14	.25
74LS55	14	.29
74LS73	14	.39
74LS74	14	.39
74LS75	16	.39
74LS76	16	.39
74LS78	14	.39
74LS83	16	.65
74LS85	16	.69
74LS86	14	.39
74LS90	14	.55

74LS92	14	.55
74LS93	14	.55
74LS95	14	.79
74LS96	16	.89
74LS107	14	.39
74LS109	16	.39
74LS112	16	.39
74LS113	14	.39
74LS114	14	.39
74LS122	14	.49
74LS123	16	.79
74LS125	14	.49
74LS126	14	.49
74LS132	14	.59
74LS133	16	.59
74LS136	14	.39
74LS138	16	.59
74LS139	16	.59
74LS151	16	.59
74LS153	16	.59
74LS154	24	.99
74LS155	16	.69
74LS156	16	.69
74LS157	16	.69
74LS158	16	.59
74LS160	16	.69
74LS161	16	.69
74LS162	16	.69
74LS163	16	.69
74LS164	14	.69
74LS165	16	1.19
74LS168	16	1.19
74LS169	16	1.19
74LS170	16	1.49
74LS173	16	.69
74LS174	16	.59
74LS175	16	.59
74LS181	24	2.49
74LS190	16	.89
74LS191	16	.89

74LS192	16	.79
74LS193	16	.79
74LS194	16	.69
74LS195	16	.69
74LS197	14	.79
74LS221	16	.89
74LS240	20	1.09
74LS241	20	1.09
74LS242	14	1.09
74LS243	14	1.09
74LS244	20	1.09
74LS245	20	1.49
74LS247	16	1.09
74LS248	16	1.09
74LS249	16	1.09
74LS251	16	.59
74LS253	16	.59
74LS257	16	.59
74LS258	16	.59
74LS260	14	.59
74LS266	14	.69
74LS273	20	1.49
74LS279	16	.49
74LS283	16	.69
74LS290	14	.89
74LS293	14	.79
74LS298	16	.89
74LS352	16	1.29
74LS353	16	1.29
74LS365	16	.49
74LS366	16	.49
74LS367	16	.49
74LS368	16	.49
74LS373	20	1.29
74LS374	20	1.29
74LS375	16	.69
74LS386	14	.45
74LS393	14	1.19
74LS399	16	1.49
74LS670	16	1.49
81LS95	20	1.49
81LS97	20	1.49

74S/PROMS*

74S00	14	.35
74S02	14	.35
74S03	14	.35
74S04	14	.45
74S05	14	.45
74S08	14	.39
74S09	14	.39
74S10	14	.35
74S11	14	.35
74S15	14	.35
74S20	14	.35
74S22	14	.35
74S30	14	.35
74S32	14	.45
74S38	14	.89
74S40	14	.39
74S51	14	.35
74S64	14	.39
74S65	14	.39
74S74	14	.55
74S86	14	.55
74S112	16	.55
74S113	14	.55
74S114	14	.55

74S124	16	2.95
74S133	16	.45
74S134	16	.50
74S135	16	.69
74S136	14	1.39
74S138	16	.89
74S139	16	.89
74S140	14	.55
74S151	16	.99
74S153	16	.99
74S157	16	.99
74S158	16	.99
74S160	16	2.49
74S174	16	.99
74S175	16	.99
74S188*	16	1.49
74S194	16	1.49
74S195	16	1.49
74S196	14	1.49
74S240	20	2.25
74S241	20	2.25
74S242	14	2.49

74S243	14	2.49
74S244	20	2.49
74S251	16	1.19
74S253	16	1.19
74S257	16	1.19
74S258	16	1.19
74S260	14	.79
74S280	14	1.95
74S287*	16	1.95
74S288*	16	1.95
74S373	20	2.49
74S374	20	2.49
74S387*	16	1.95
74S471*	20	5.95
74S472*	20	4.95
74S473*	20	4.95
74S474*	24	4.95
74S475*	24	4.95
74S570*	16	2.95
74S571*	16	2.95
74S572*	18	4.95
74S573*	18	4.95
74S940	20	2.49
74S941	20	2.49

CA—LINEAR

CA3010H		.99
CA3013H		2.15
CA3023H		3.25
CA3035H		5.95
CA3039H		1.35
CA3046N	14	.89
CA3059N	14	3.25

CA3060N	16	3.25
CA3080E	8	.89
CA3081N	16	1.49
CA3082N	16	1.49
CA3083N	16	1.49
CA3086N	14	.69

CA3089N	16	1.69
CA3096N	16	1.19
CA3130E	8	1.49
CA3140E	8	.99
CA3160H		1.95
CA3401N	14	.59
CA3600N	14	3.95

CD—CMOS

CD4000	14	.29
CD4001	**14**	**.29**
CD4002	14	.29
CD4006	14	.89
CD4007	14	.29
CD4009	**16**	**.39**
CD4010	16	.39
CD4011	14	.29
CD4012	**14**	**.15**
CD4013	14	.39
CD4014	16	.79
CD4015	**16**	**.39**
CD4016	14	.39
CD4017	16	.75
CD4018	16	.79
CD4019	16	.39
CD4020	16	.75
CD4021	16	.79
CD4022	16	.79
CD4023	14	.29
CD4024	14	.69
CD4025	14	.23
CD4026	16	2.49
CD4027	16	.45
CD4028	16	.69
CD4029	16	.79
CD4030	14	.39
CD4034	24	1.95
CD4035	16	.89

(More in Catalog)

CD4040	16	.79
CD4041	14	.79
CD4042	16	.69
CD4043	16	.79
CD4044	16	.79
CD4046	16	.89
CD4047	14	.89
CD4048	16	.39
CD4049	**16**	**.39**
CD4050	16	.39
CD4051	16	.79
CD4052	16	.79
CD4053	16	.79
CD4056	16	2.95
CD4059	24	7.95
CD4060	16	.89
CD4066	14	.39
CD4068	14	.39
CD4069	14	.29
CD4070	14	.39
CD4071	14	.29
CD4072	14	.29
CD4073	14	.29
CD4075	14	.29
CD4076	16	.79
CD4078	14	.49
CD4081	**14**	**.29**
CD4082	14	.29
CD4093	14	.49

CD4098	16	1.95
CD4506	16	1.19
CD4507	14	.39
CD4508	24	3.95
CD4510	16	.89
CD4511	16	.89
CD4512	16	.89
CD4514	24	1.79
CD4515	24	1.79
CD4516	16	.99
CD4518	16	.99
CD4519	16	.39
CD4520	16	.79
CD4526	16	1.19
CD4528	16	1.19
CD4529	16	1.19
CD4543	16	1.19
CD4562	14	6.95
CD4566	16	1.39
CD4583	16	2.49
CD4584	14	.59
CD4723	16	1.19
CD4724	16	1.19
MC14409	16	13.95
MC14410	16	13.95
MC14411	24	11.95
MC14412	16	13.95
MC14419	16	7.95
MC14433	24	13.95
MC14538	16	1.19
MC14541	14	1.19

MICROPROCESSOR COMPONENTS

MICROPROCESSOR CHIPS

Part No.	**Pins	Function	Price
CDP1802	40	CPU	$9.95
2650	40	MPU	14.95
IDM2901ADC	40	CPU—4-bit slice (Com. Temp. Gr.)	19.95
MCS6502	40	MPU w/Clock	9.95
MCS6502B	40	MPU w/Clock at 3MHz	13.95
MC6802CP	40	MPU w/Clock and RAM	7.95
INS8035N-6	40	MPU—8-bit (6MHz)	5.95
INS8039N-6	40	CPU-Sgl. chip 8-bit (128 bts. Ram)	5.95
INS8040N-6	40	CPU (256 bytes RAM)	5.95
INS8070N	40	CPU (64 bytes RAM)	11.95
INS8073N	40	CPU w/Basic Micro Interpreter	14.95
P8085A	40	CPU	5.95
8155	40	HMOS RAM I/O Port-Timer	7.95
8748	40	HMOS EPROM MPU	24.95

Z80, Z80A, Z80B, Z8000 SERIES

Z80	40	CPU (MK3880N)(780C) 2MHz	$4.95
Z80-CTC	28	Counter Timer Circuit	5.95
Z80-DART	40	Dual Asynchronous Rec./Trans.	11.95
Z80-DMA	40	Direct Memory Access Circuit	15.95
Z80-P10	40	Parallel I/O Interface Controller	5.95
Z80-S10/0	40	Serial I/O (TxCB and RxCB Bonded)	15.95
Z80-S10/1	40	Serial I/O (Lacks DTRB)	15.95
Z80-S10/2	40	Serial I/O (Lacks SYNCB)	15.95
Z80-S10/9	40	Serial I/O	15.95
Z80A	40	CPU (MK3880N-4)(780C-1) 4MHz	5.95
Z80A-CTC	28	Counter Timer Circuit	5.95
Z80A-DART	40	Dual Asynchronous Rec./Trans.	11.95
Z80A-DMA	40	Direct Memory Access Circuit	17.95
Z80A-P10	40	Parallel I/O Interface Controller	5.95
Z80A-S10/0	40	Serial I/O (TxCB and RxCB bonded)	16.95
Z80A-S10/1	40	Serial I/O (Lacks DTRB)	16.95
Z80A-S10/2	40	Serial I/O (Lacks SYNCB)	16.95
Z80A-S10/9	40	Serial I/O	16.95
Z80B	40	CPU (MK3880N-6) 6MHz	11.95
Z80B-CTC	28	Counter Timer Circuit	13.95
Z80B-P10	40	Parallel I/O Interface Controller	13.95
Z8001	48	CPU Segmented	51.95
Z8002	40	CPU Non-Segmented	55.95
Z8030	40	Serial Comm. Controller	44.95
Z8036	40	Counter/Timer & Parallel I/O Unit	29.95

6800/68000 SERIES

MC6800	40	MPU	4.95
MC6802CP	40	MPU with clock and RAM	7.95
MC6810API	24	128x8 Static RAM	3.95
MC6821	40	Peripheral Inter. Adapt (MC6820)	4.95
MC6828	24	Priority Interrupt Controller	15.95
MC6830L8	24	1024x8-bit ROM (MC68A30-8)	10.95
MC6850	24	Asynchronous Comm. Adapter	4.95
MC6852	24	Synchronous Serial Data Adapter	5.75
MC6860	24	0-600bps Digital MODEM	9.95
MC6862	24	2400bps Modulator	12.95
MC6880A	16	Quad 3-state bus. trans. (MC8T26)	2.25
MC68000L8	64	MPU 16-Bit (8MHz)	69.95
MC68488P	40	General Purpose Int. Adapter	8.95
MC68652P2	40	Multi. Protocol Comm. Controller	24.95
MC68661PB	28	Enhanced Prog. Comm. Int.	8.95
MCM68764	24	64K EPROM (450ns)	39.95
SY6522	40	Peripheral Inter. Adapter	7.95

8080A SERIES

INS8080A	40	CPU	3.95
TMS5501	40	Synchronous Data Interface (SIRC)	14.95
INS8154	40	128 Byte RAM 16-Bit I/O	13.95
INS82C06	20	Octal D Flip Flop Tri-State (74C374)	2.49
DP8212	24	8-bit Input/Output (74S412)	2.25
DP8214	24	Priority Interrupt Control	3.95
DP8216	16	Bi-Directional Bus Driver	2.25
DP8224	16	Clock Generator/Driver	2.25
DP8226	16	Bus Driver	2.25
DP8228	28	System Cont./Bus Driver (74S428)	3.49
DP8238	28	System Controller (74S438)	4.49
INS8243	24	I/O Expander for 48 Series	5.95
INS8245	18	16-Key Keyboard Encoder (74C922)	4.49
INS8246	20	20-Key Keyboard Encoder (74C923)	4.95
INS8247	28	Display Controller (74C911)	8.95
INS8248	28	Display Controller (74C912)	8.95
INS8250N	40	Asyn. Comm. Element	10.95
DP8251	28	Prog. Comm. I/O (USART)	4.49
DP8253	24	Prog. Interval Timer	6.95
DP8255	40	Prog. Peripheral I/O (PPI)	4.49
DP8257	40	Prog. DMA Control	7.95
DP8259	28	Prog. Interrupt Control	6.95
DP8275	40	Prog. CRT Controller	29.95
DP8279	40	Prog. Keyboard/Display Interface	8.95
DP8303	20	8-Bit Tri-State Bi-Directional Trans.	3.95
DP8304	20	8-bit Bi-Directional Receiver	2.49
DP8307	20	8-bit Bi-Directional Receiver	2.49
DP8308	20	8-bit Bi-Directional Receiver	2.49
DP8310	20	Octal Latched Peripheral Driver	4.95
DP8311	20	Octal Latched Peripheral Driver	4.95

DISK CONTROLLERS

INS1771-1	40	Single Density	16.95
FD1791	40	Single/Dual Density (Inv.)	24.95
FD1793	40	Single Density Inverted	26.95
FD1795	40	Dual Density/Side Select (Inv.)	49.95
FD1797	40	Dual Density/Side Select True	49.95

SPECIAL FUNCTION

DS0025CN	8	Dual MOS Clock Driver (5MZ)	2.49
DS0026CN	8	Dual MOS Clock Driver (5MZ)	1.95
INS1771N-1	40	Floppy Disk Controller	16.95
INS2651N	28	Communication Chip	8.95
MM58167N	24	Microprocessor Real Time Clock	8.95
MM58174N	16	Micro. Compatible Time Clock	7.95
COP402N	40	Microcontroller w/64-digit RAM and Direct LED Drive	5.95
COP402MN	40	Microprocessor w/64-digit RAM & Direct LED Drive w/N Buss Int.	5.95
COP470N	20	32-seg. VAC Fluor. Drvr. (20-pin pkg.)	3.25
MM5369EST	8	Prog. Oscillator/Divider (100Hz)	1.19

DYNAMIC RAMS

Part No.	**Pins			Price
1103	18	1024x1	(300ns)	.99
4027	**16**	**4096x1**	**(250ns)**	**2.49**
4116N-2	16	16,384x1	(150ns)	1.89 - 8/14.95
4116N-3	16	16,384x1	(200ns)	1.69 - 8/12.95
4116N-4	16	16,384x1	(250ns)	1.49 - 8/10.95
4164N-150	16	65,536x1	(150ns)	7.95 - 8/59.95
4164N-200	16	65,536x1	(200ns)	7.49 - 8/54.95
MM5261	18	1024x1	(300ns)	.49 - 8/1.95
MM5262	**22**	**2048x1**	**(365ns)**	**.49 — 8/1.95**
MM5270	18	4096x1	(250ns) MK4096	4.95
MM5280	22	4096x1	(200ns) 2107	3.95
MM5290-2	16	16,384x1	(150ns)	1.89 - 8/14.95
MM5290-3	16	16,384x1	(200ns)	1.69 - 8/12.95
MM5290-4	16	16,384x1	(250ns)	1.49 - 8/10.95
MM5298-3	16	8192x1	(200ns)	1.69

STATIC RAMS

1101	16	256x1	(650ns)	1.49
2101	22	256x4	(450ns) 8101	2.49
2102	16	1024x1	(350ns)	.89
21L02	16	1024x1	(450ns) L.P.	1.49
2111	18	256x4	(450ns) 8111	2.95
2112	16	256x4	(450ns) MOS	2.95
2114	18	1024x4	(450ns)	1.95 - 8/13.95
2114L	18	1024x4	(450ns) L.P.	2.25 - 8/15.95
2114-2	18	1024x4	(200ns)	2.25 - 8/15.95
2114L-2	18	1024x4	(200ns) L.P.	2.49 - 8/17.95
2147	18	4096x1	(70ns)	4.95
2148	18	1024x4	(70ns)	8.95
TMS4044	18	4096x1	(450ns)	3.95
TMS4045	18	1024x4	(450ns)	3.95
5101	22	256x4	(450ns) CMOS	4.95
MM5257	18	4096x1	(450ns) 4044	4.95
HM6116P-3	24	2048x8	(150ns) CMOS	7.95
HM6116-4	24	2048x8	(200ns) CMOS	6.95
HM6116LP-4	24	2048x8	(200ns) L.P. CMOS	7.95
7489	16	16x4	(50ns)	2.25
74C921	18	256x4	(250ns) CMOS	3.95
74C929	16	1024x1	(250ns) CMOS (6501)	3.95
74C930	18	1024x1	(250ns) CMOS (6518)	3.95
74S189	16	16x4	(35ns) 93405	1.95
74S200	16	256x1	(80ns) 93410	3.95
74S206	16	256x1	(60ns) 93411	3.95
74S289	16	16x4	(35ns) 3101	2.25
82S10	16	1024x1	(50ns) O.C. (93415)	3.95
82S25	16	16x4	(50ns) O.C. (74S289)	2.25

EPROMS

1702A	24	256x8	(1us)	4.95
2708	24	1024x8	(450ns)	3.95
2708-5	24	1024x8	(550ns) SM00246	2.95
TMS2516	24	2048x8	(450ns) 2716	6.95
TMS2532	24	4096x8	(450ns) NMC2532	9.95
TMS2564	28	8192x8	(450ns)	19.95
TMS2716	24	2048x8	(450ns) 3 voltage	7.95
2716	24	2048x8	(450ns)	4.95
2716-1	24	2048x8	(350ns)	6.95
2732	24	4096x8	(450ns)	9.95
27580	24	1024x8	(450ns) single +5V	2.95
MM2764	28	8192x8	(450ns)	16.95
MM2764-3	28	8192x8	(300ns)	19.95
MCM68764	24	8192x8	(450ns)	39.95
74S188	16	32x8	PROM O.C. (6330-1)	1.49
74S287	16	256x4	PROM T.S. (6301-1)	1.95
74S288	16	32x8	PROM T.S. (6331-1)	1.95
74S387	16	256x4	PROM O.C. (6300-1)	1.95
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74HC164	14	1.79
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74HC174	16	1.39
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74C903	14	.59
74C906	14	.59
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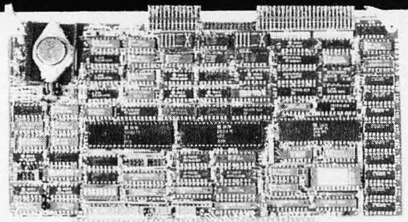
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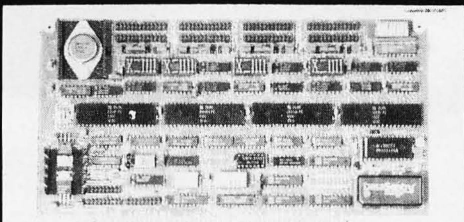
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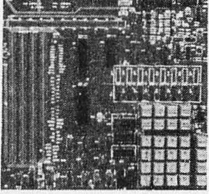
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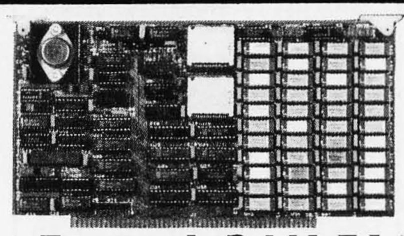
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- Switch selectable PROM or monitor restart
- Vectored interrupts provided by Z80-CTC and Z80-P10

BV SDS38007	Z80 Starter System (A&T) (Shipping Weight 4 lbs.)	$450.00	$382.00



ExpandoRAM IV

256K Dynamic RAM

- S-100 (IEEE/696) compatible
- 256 K Configuration
- DIP Switch Selectable Addressing
- Board may reside anywhere in the 24 Bit address space of the IEEE-696 Bus
- 8 and 16 Bit data Transfers
- Parity Check
- Optional Error Detection/Correction
- Invisible refresh at end of any OP code fetch forced refresh cycle every 10-16 microseconds
- Error Detection and Correction (Hamming Code) 1 bit correction-optional
- 1 Year Warranty

Part No.	Description	List Price	Our Price
BV SDS38088	ExpandoRAM IV 256K (A&T)	$1145.00	$ 980.00
BV SDS38089	ExpandoRAM IV 256K w/EDC (A&T)	$1990.00	$1780.00

ExpandoRAM III

Random Access Memory Board

- POWER: +7V to +10V @ 400 mA (max)
- 1 year warranty
- Phantom output disable or manual switch selectable output disable
- Typical power dissipation of 5 watts
- 4 MHz operation
- Port addressable board select for multi-user system
- POWER: (2 S memory cycle) +7V to +10 V @ 400 mA (max)
- 1 Year Warranty

BV SDS38097	256K ExpandoRAMIII /696 (A&T)	$825.00	$598.89

ROM DISK 128

Program Accellerator

- S-100 (IEEE/696) compatible
- 128K Bytes of storage per board
- Uses 16 user supplied 2764 or 2732 type EPROMs
- Up to four boards per system for a total of 512 K
- Meets all IEEE 696/S-100 specifications
- Serial Port provided (using 8251 UART)
- Dip switch selectable addressing
- Looks like a disk drive to the system
- Eliminates media problems
- CP/M Plus support porvided
- Ideal for environments where mechanical drives are not practical
- CP/M® and MP/M® install programs
- 1 Year Warranty

BV SDS38081	ROM DISC 128K w/o EPROMS (A&T)	$350.00	$296.00
BV SDS61103	ROM DISC Manual		
BV PGC26S24DS	2' Internal Serial I/O cable		

RAM DISK 256

Program Accellerator

- S-100 (IEEE/696) compatible
- 256K bytes of sequentially accessed memory
- On-board transparent refresh (only when the M1 signal is stopped)
- Faster than a floppy disk drive
- Install program included (when configured the RAM DISK-256 looks like a single density 8" disk drive)
- Source code libraries included
- On-board dynamic RAM controller
- Bank addressing allows the use of four boards in the same address to be accessed giving you up to 1 Mbyte of storage
- Asynchronous bus operation and uses the WAIT line only as needed
- 1 Year Warranty

Part No.	Description	List Price	Our Price
BV SDS38082	Ram Disk 256K (A&T)	$875.00	$715.00
BV SDS61102	Manual		$ 10.00

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PRIORITY ONE ELECTRONICS

THE INDUSTRY STANDARD



CPU BOARDS

68K - 68000 16 BIT CPU

16 bit 8 or 10 MHz on-board sockets for 2716, 2732, or 2764 EPROMs for up to 8K x 16 of memory

Part No.	Description	List Price	Our Price
BV GBT184A	A&T 8MHz	$695.00	$512.95
BV GBT184C	CSC 10MHz	$850.00	$765.00

CP/M® 68K NOW AVAILABLE!!

FORTH OPERATING SYSTEM INCLUDED

Now CompuPro and Digital Research bring you CP/M for the 68000. Also included is the FORTH Operating System which requires a DISK I, 64K of CompuPro memory and an INTERFACER 3 or 4.

BV GBTCPM68K	68000 CP/M® & FORTH O/S	$350.00

CO-PROCESSOR 8086/8087

16 bit 8 or 10 MHz 8086 CPU with sockets for 8087 and 80136

BV GBT186A	A&T 8MHz 8086 only	$ 750.00	$494.95
BV GBT186C	CSC 10MHz 8086 only	$ 850.00	$764.89
BV GBT186A87	A&T with 8087 option	$1050.00	$939.00
BV GBT186C87	CSC with 8087 option*	$1150.00	$1065.00

*8087 Limits clock speed to 5MHz

DUAL PROCESSOR 8085-8088

6 or 8 MHz provides true 16 Bit Power with a standard 8 bit S-100 bus.

BV GBT1612A	A&T 6MHz	$495.00	$318.97
BV GBT1612C	CSC 6/8 MHz	$595.00	$497.87

CPUZ - Z80B CPU NOW 6MHz!

3/6 MHz Z80B CPU with 24 Bit Addressing.

FASTEST Z80 CPU AVAILABLE!

BV GBT160A	3/6 MHz A&T	$325.00	$228.95
BV GBT160C	3/6 MHz CSC	$425.00	$374.87

DISK CONTROLLERS

DISK 1 DMA FLOPPY CONTROLLER

Fast DMA, Soft Sector, Controls Up to Four 8" or 5¼" Single or Double Density Drives!

BV PDB171ACPM	A&T w/CPM 2.2® & BIOS	$670.00	$489.00
	When purchased w/two 8" disk drives only		$450.00
BV PDB171CCPM	CSC w/CP/M 2.2® & BIOS	$770.00	$595.00
BV GBT171A	Disk 1 Controller A&T	$495.00	$368.95
BV GBT171C	Disk 1 Controller CSC	$595.00	$550.00
BV GBTCPM80	CP/M 2.2® for Z80/8085 w/manual & BIOS 8" S/D disk		$148.95
BV GBTCPM86	CP/M 2.2® for 8086 w/manuals & BIOS 8" S/D disk		$258.95

DISK 2/SELECTOR CHANNEL HARD DISK CONTROLLER

Fast DMA 2 board set controls 4 Shugart 4000 series or Fujitsu 2300 type drives. Includes CP/M 2.2®.

BV GBT177A	Assembled & Tested	$795.00	$568.95
BV GBT177C	CSC	$895.00	$850.00

M-DRIVE/H PROGRAM ACCELLERATOR

Interfaces through two I/O ports, and runs at 10MHz IEEE 696 compatible. Requires any CompuPro CPU and a DISK 1. Each board contains 512K of fast, low power (900mA) RAM, with parity checking.

BV GBT197A	M-DRIVE/H w/software, A&T	$1895.00	$1249.00
BV GBT197C	M-DRIVE/H w/software, CSC	$2095.00	$1495.00

STATIC RAM

RAM 17 - 64K CMOS STATIC RAM

12 MHz, RAM 17, 2 Watt, DMA Compatible 24 Bit Addressing

BV GBT175A64	64K A&T 12MHz	$499.00	$460.00
BV GBT175C64	64K CSC 12MHz	$599.00	$550.00

RAM 16 - 32K x 16 BIT CMOS STATIC RAM

8 and/or 16 Bit 12MHz, RAM 16, 32K x 16 or 64K x 8 IEEE/696 16 Bit 2 Watt, 24 Bit Addressing, 12MHz

BV GBT180A	64K A&T 12MHz	$550.00	$510.00
BV GBT180C	64K CSC 12MHz	$650.00	$610.00

RAM 21 - 128K STATIC RAM

816 RAM 21 12MHz, 128K x 8 or 64K x 16 IEEE/696 8 or 16 Bit, 1.2 Amps, 24 Bit Addressing, 12MHz

BV GBT190A	128K A&T	$1095.00	$858.95
BV GBT190C	128K CSC	$1245.00	$1125.00

I/O BOARDS

SYSTEM SUPPORT 1 MULTIFUNCTION BOARD

Serial port (software prog. baud), 4K RAM included, 15 levels of interrupt, real time clock, optional math processor.

Part No.	Description	List Price	Our Price
BV GBT162A	Assembled & Tested	$450.00	$308.95
BV GBT162C	CSC	$550.00	$495.00
BV GBT8231	Math Chip		$195.00
BV GBT8232	Math Chip		$195.00
BV GBT162AM1	A&T w/8231 Math Chip	$645.00	$538.95
BV GBT162CM1	CSC w/8231 Math Chip	$745.00	$670.00
BV GBT162AM2	A&T w/8232 Math Chip	$645.00	$538.95
BV GBT162CM2	CSC w/8232 Math Chip	$745.00	$670.89

S-100 MOTHERBOARDS

Active Termination, 6-12-20 Slot

BV GBT153A	A&T 6 slot (2 lbs.)	$140.00	$125.00
BV GBT153C	CSC 6 slot (2 lbs.)	$190.00	$155.00
BV GBT154A	A&T 12 slot (3 lbs.)	$175.00	$155.00
BV GBT154C	CSC 12 slot (3 lbs.)	$240.00	$220.00
BV GBT155A	A&T 20 slot (4 lbs.)	$265.00	$235.00
BV GBT155C	CSC 20 slot (4 lbs.)	$340.00	$310.00

INTERFACER 1

Two Serial I/O

BV GBT133A	Assembled & Tested	$295.00	$198.95
BV GBT133C	CSC	$370.00	$329.00

INTERFACER 2

Three parallel, one serial I/O board

BV GBT150A	Assembled & Tested	$325.00	$249.00
BV GBT150C	CSC	$399.00	$359.00

INTERFACER 3

Eight-channel multi-user serial I/O board

BV GBT1748A	Assembled & Tested	$699.00	$518.95
BV GBT1748C	CSC 200 hr. 8 port	$849.00	$748.89
BV GBT1745A	Assembled & Tested	$599.00	$448.95
BV GBT1745C	CSC 200 hr. 5 port	$699.00	$628.89

INTERFACER 4

Three Serial, 1 Parallel, 1 Centronics Parallel

BV GBT187A	Assembled & Tested	$450.00	$314.87
BV GBT187C	CSC	$540.00	$414.87

MPX CHANNEL BOARDS

I/O Multiplexer, using 8085A-2 CPU on board w/16K RAM

BV GBT166A16	Assembled & Tested	$649.00	$584.89
BV GBT166C16	CSC	$749.00	$674.89



STATIC RAM SALE!!

256K AND 128K IEEE/696 S-100 - ULTRA LOW POWER!

256K RAM 22

- Fully static design eleiminates timing problems associated with Dynamic RAMs (<4 Watts)
- Guaranteed to work with any IEEE/696 S-100 DMA device
- 24 bit extended addressing
- 8 or 16 bit data
- Single 5V operation
- Assembled and Tested

BV GBT198A

12 MHz

SUPER SALE PRICE:

$1500.00

EACH, WHEN YOU BUY 2 OR MORE

$1595.00 Each

128K RAM 21

- Fully static design uses less power than dynamics (1.2A typical)
- 24 bit extended addressing
- 8 or 16 bit data
- 16K window deselect
- Switch selectable PHANTOM disable
- Fully DMA compatible
- Assembled and Tested

BV GBTRAM21 LIST PRICE: $1295.00

12 MHz

SUPER SALE PRICE:

$650.00

EACH, WHEN YOU BUY TWO OR MORE

$695.00 Each

64K 10MHz LOW POWER S-100 IEE/STATIC RAMS

RAM 17

64K 8 BIT / 24 BIT ADDRESS

BV GBTRAM17 List Price: $499.00

$299.00

RAM 16

64K 8 or 32K 16 BIT / 24 BIT ADDRESS

BV GBTRAM16 List Price: $550.00

$325.00



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TELETEK
THE SYSTEMASTER Z80 SINGLE BOARD COMPUTER

FEATURES:
• Z80A 4 MHz CPU with 64K bytes of on-board RAM • RAM is partitioned into two banks. One is always active, and the other deselectable, *allowing the use of MP/M* • Provisions for and EPROM (2716, 2732, or 2764) • Two RS232 serial I/O ports, 45 to 19,200 baud • Two 8 bit parallel I/O ports • DMA floppy disk controller • Single or double density, single or double sided • Controls up to 4 drives of 5 1/4" or 8" drives • Simultaneous operation of four 8" and 5¼" drives • Real time clock

SysteMaster® For Operation With CP/M®

Part No.	Description	List Price	Our Price
BV TLKA1001	Configured with a 250 nS prewrite comp for use with Sugart and Siemens 3" drives	$895.00	$850.00
BV TLKA1002	Configured with a 0 nS prewrite comp for use with Qume, Tandon, Mitsubishi and MPI8" drives	$895.00	$850.00
SysteMaster® For Operation with TurboDOS™			
BV TLKA1003	Configured with a 250 nS prewrite comp for use with Shugart and Siemens 8" drives	$895.00	$850.00
BV TLKA1004	Configured with a 0 nS prewrite comp for use with Qume, Tandon, Mitsubishi, and MPI 8" drives	$895.00	$850.00

Shipping weights on above items: 2 lbs. each

SBC-1 Z80A SLAVE PROCESSOR

FEATURES:
• Z80A 4MHz, or Z80B 6MHz CPU • 128K (fully populated) on board RAM • Memory can be partioned onto 4K segments on any 4K boundary • Provisions for one 2716, 2732, or 2764 EPROM • Two RS232 serial ports, 45 to 19,200 baud • Two parallel ports

Part No.	Description	List Price	Our Price
BV TLKA1027	4MHz SBC-1 w/128K RAM	$ 945.00	$ 895.00
BV TLKA1028	6MHz SBc-1 w/128K RAM	$11.,5.00	$1050.00

LONG DISTANCE ADAPTOR BOARDS

BV TLKA1200	PSC (RS232) long distance interface up to 50 ft.	$125.00
BV TLKA1202	PSC (RS422) long distance interface up to 4000 ft	$125.00
BV TLKA1220	PPD parallel interface for up to 250 ft.	$ 65.00

Z80A MULTI-FUNCTIONED CPU BOARD

FEATURES:
• Z80 4MHz CPU
• Floppy disk controller: Controlls single/double sided, single/double density, 5 1/4" and 8" disk drives or both at the same time (4 drives maximum) • On board 2716 monitor EPROM • Provisions for two more 2716 EPROMs • Two RS232 serial ports (45 to 9600 baud) • Two parallel ports • Real time clock • PROM programmer for 2716's (requires an external voltage source)

Part No.	Description	List Price	Our Price
BV TLKA1099	FDC-1 0 nS prewrite comp for use with QUME, MITSUBISHI, TANDON, and MPI	$695.00	$660.00
BV TLKA1105	FDC-1 250 nS prewrite comp for use with SHUGART, and SIEMENS	$695.00	$660.00

256K DYNAMIC MEMORY BOARD

FEATURES:
• Guaranteed to operate at 4 MHz with no wait states • 256K dynamic RAM uses the popular 4164 IC • PHANTOM signal disables output of data from the memory board • On board refresh • Timing changes are done with jumpers to allow operation with 8080, Z80, 8085, or Alpha Micro CPUs • Each of 16 banks are made up of 4K byte segments • Each segment may be individually enabled or disabled

Part No.	Description	List Price	Our Price
BV TLKA1066	Populated to 64K	$550.00	$520.00
BUTLKA1069	Populated to 256K	$995.00	$945.00

HARD DISK/CARTIDGE TAPE CONTROLLER

FEATURES:
• A Z 80A CPU • Support of 5¼" rigid-disk drives (ST506 or equivalent) with • Controller communications with the host processor via 2K • Two 28-pin sockets allowing the use of up to 16K bytes of on-board EPROM and up to 8K bytes of on-board RAM • Cartridge tape drive • Expansion is made possible with an external card.
Available early 4th Quarter of 1983

BV TLKA1130	Hard Disk/Tape controller 4MHz	$795.00	$750.00
BV TLKA1131	Hard Disk/Tape controller 6MHz	$845.00	$795.00

4 SERIAL AND 2 PARALLEL BOARD

FEATURES:
• 2 RS232 serial ports with full handshaking, (45-19,200) baud • Each port is speed independent • The Z80A CTC may be implemented as a real time clock • Two parallel ports with the Z80A PIO IC

Part No.	Description	List Price	Our Price
BV TLKA1175	PSIO 4 serial 2 parallel ports	$325.00	$295.00

Industrial Computer Designs
S-100 TO "REAL WORLD" INTERFACE PRODUCTS
64 INPUT 8 BIT A/D D/A CONVERTERS

Part Number	Description	Price
BV ICDAD64100	64 input 8 bit S-100 A/D board	$295.00
BV ICDDA64100	64 output 8 bit S-100 D/A board	$395.00

REMOTE SENSORS, ALARMS, VALVES, AND CONTROLLERS FOR USE WITH ABOVE A/D D/A CONVERTER BOARDS

BV ICDRTS1	remote temperature sensor (1 lb.)	$ 29.95
BV ICDRLS1	remote light sensor (1 lb.)	$ 29.95
BV ICDRMS1	remote moisture sensor (1 lb.)	$ 59.95
BV ICDRSDA1	rewmote smoke detector alarm (2 lbs.)	$129.00
BV ICDDNVAC1	in-line remote air-conditioner & heating controller (1 lb.)	$ 94.95

Air Conditioning & Heating Duct Valves

BV ICDADV07	7" diameter valve (4 lbs.)	$ 74.95
BV ICDADV08	8" diameter valve (4 lbs.)	$ 75.95
BV ICDADV09	9" diameter valve (5 lbs.)	$ 76.95
BV ICDADV10	10" diameter valve (5 lbs.)	$ 79.95
BV ICDADV11	11" diameter valve (6 lbs.)	$ 81.95
BV ICDADV12	12" diameter valve (6 lbs.)	$ 83.95
BV ICDADV13	13" diameter valve (6 lbs.)	$ 84.95
BV ICDADV14	14" diameter valve (6 lbs.)	$ 85.95

64 PIN CABLE ASSEMBLIES

BV ICD464PCA	64 pin single ended 4' long (2 lbs.)	$ 59.25
BV ICD1064PCA	64 pin single ended 10' long (3 lbs.)	$ 89.95
BV ICD2064PCA	64 pin single ended 20' long (6 lbs.)	$145.00

"HOW TO" APPLICATION NOTES

If you would like to learn more about the ICD Designer Control Series of peripherals, ICD offers a complete collection of "How To" applications notes. See how your computer can control your home or office, or be used as part of an industrial control system.

BV ICDAPN	Application notes (1 lb.)	$ 15.00

S-100 CLOCK/CALENDAR BOARDS

BV ICDACA100	With alarm circuit	$228.00
BV ICDCT100	With timer down to .01 second	$345.00
BV ICDCTS	Software for ICDCT100 board on 8" CP/M format	$ 34.95



Intercontinental Micro Systems
Z80A DMA SBC & Z80B SLAVES
S-100 IEEE/696 COMPATIBLE - 1 YEAR WARRANTY!

CPZ-48000 FEATURES:
• 4MHz Z80A, 64K RAM
• Floppy disk personality card included for 5¼" or 8" floppy disk drives
• RS232 personality card included
• Two serial - two parallel I/Os

SLAVE PROCESSOR
• Z80 4 or 6MHz CPU (specify at time of order)
• Two serial - two parallel I/Os
• 64K RAM
• TURBODOS compatible

Part Number	Description	List Price	SALE PRICE
BV ICMCPZ480008	SBC for 8" floppy	$995.00	$895.00
BV ICMCPZ480005	SBC for 5¼" floppy	$995.00	$895.00
BV ICM256KMB	256 KByte RAM	$995.00	$895.00
BV ICMCPS4A	4MHz slave/asynch. port	$475.00	$439.00
BV ICMCPS4S	4MHz slave/synch. port	$485.00	$445.00
BV ICMCPS6A	6MHz slave/asynch. port	$550.00	$489.00
BV ICMCPS6S	6MHz slave/synch port	$560.00	$499.00
	(Shipping weight: 2 lbs. each)		
BV ICMRS232	RS232 Personality Card		$ 25.00
BV ICMCENTD	Centronics Parallel Personality Card		$ 28.00
BV ICM8FDC	8" Floppy Disk Personality Card		$ 36.00
BV ICM5FDC	5¼" Floppy Disk Personality Card		$ 33.00
BV ICMCLKCAL	Clock Calendar		$ 48.00

TELETEK SOFTWARE

Software with no prewrite compensation installed.

Part Number	Description	Price
CP/M® For SysteMaster®		
BV TLKB1001	CP/M® on 8" and 5¼" 35 track disks	$135.00
CP/M® FOR FDC-1		
BV TLKB1031	CP/M® on 8" and 5¼" 35 track disks	$135.00
TurboDos™ For All TELETEK Floppy Controllers		
BV TLKB1238	V1.22 single user	$300.00
BV TLKB1239	V1.22 single user w/spooling	$350.00
BV TLKB1240	V1.22 multi user, single user, & spooling software	$750.00

Software with a 250 nS prewrite compensation installed.

CP/M® For The SysteMaster™		
BV TLKB1006	CP/M® on 8" and 5¼" 35 track disks	$135.00
BV TLKB1010	CP/M® on 8" for TANDON TM848 THINLINE	$135.00
CP/M® For the FDC-1		
BV TLKB1036	CP/M® on 8" and 5¼" 35 track disks	$135.00
BV TLKB1040	CP/M® on 8" for TANDON TM848 THINLINES	$135.00

SSM

IO5
2 Serial, 3 Parallel S-100 Interface

Part No.	Description	List Price	Our Price
BV SSMIO5A	Assembled & Tested	$329.00	$288.95

IO8
8 Port Serial I/O S-100 Board

BV SSMIO8A	Assembled & Tested	$550.00	$450.00

IO4
2 Serial, 2 Parallel I/O S-100 Board

BV SSMIO4A	Assembled & Tested	$290.00	$245.00

2708/2716 EPROM PROGRAMMER & EPROM BOARD
Programs 2708 and 2716 EPROMs. Holds 4 2708s (4K) or 4 2716s (8K)

BV SSMMB8A	Assembled & Tested	$265.00	$219.87

DUAL

NON VOLATILE CMOS RAMS
8, 16, or 32K. 8 or 16 Bit Data. Battery Backup On Board 6MHz, Bank Selectable

BV DULCMEM8	8K A&T	$495.00	$450.00
BV DULCMEM16	16K A&T	$595.00	$550.00
BV DULCMEM32	32K A&T	$695.00	$650.00

256K DYNAMIC MEMORY
256K, 230 ns access time, 2 x 128K organization, 24 bit addressing, parity error detection.

BV DULDMEM256K	Assembled & Tested	$1295.00	$1195.00

32/64K EPROM BOARD
8 or 16 bit data, holds 2716s (32K), or 2732s (64K)

BV DULEPROM32	For 2716s A&T	$295.00	$275.00
BV DULEPROM64	For 2732s A&T	$295.00	$275.00

A/D CONVERTER
12 Bit Resolution 16 or 32 Channel Input

BV DULAIM12	Assembled & Tested	$695.00	$625.00
BV DULAIM12B	Without instru. Amp	$645.00	$598.00

D/A CONVERTER
4 Channel, 12 Bit, 3 Output Modes

BV UDULAOM12	Assembled & Tested	$695.00	$618.95

SIERRA DATA SCIENCES
S-100 SBC BOARD

Z80A 4MHz, 2 Serial RS232 interfaces, 1 parallel interface, 64K RAM, Floppy Disk Controller, provisions for one 2732 EPROM — ALL ON THIS ONE BOARD!!

BV USDSSBC	Z80A SBC A&T	$895.00	$655.00
BV USDSCPM	CP/M® perating System on 8" disk		$150.00
BV USDSTURBDS	Single User TurboDos™ on 8" disk		$450.00
BV USDSTURBDM	Multi-User TurboDos™ on 8" disk		$750.00
BV UMCP12231	36 MByte Hard Disk(45lbs)	$3695.00	$3250.00

S-100 Z80A SLAVE SBC
Z80A 4MHz, 2 RS232 Serial ports, 4 parallel ports, 64K RAM, EPROM Programmer. Used in multi-user computer system with SDSSBC.

BV SDSSBCSE	Slave Z80 SBC A&T	$825.00	$565.00



California Computer Systems

Z80 CPU 2 or 4MHz
On board RS232 Serial port, On board 2K Monitor, ROM, Power on jump to any location in 64K, LED status indicators for ROM select, halfstate and interrupts.

BV CCS2810A	Z80A 4MHz CPU A&T	$325.00	$258.95

CCS271901

BV CCS271901	2 Serial, 2 Parallel, A&T	$360.00	$288.95

CCS27201

BV CCS272001	4 Port Parallel, A&T	$275.00	$218.95

CCS271001

BV CCS271001	4 Port Serial, A&T	$325.00	$278.95

CCS2830

BV CCS283001	Assembled & Tested	$550.00	$428.95

CCS206601
64K Dynamic S-100 RAM. Cromemco CROMIX™ Compatible.

BV CCS206601	Assembled & Tested	$450.00	$425.00

CCS2422A
Floppy disk controller w/CP/M 2.2®

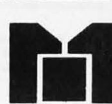
BV CCS2422A	Assembled & Tested	$475.00	$337.95

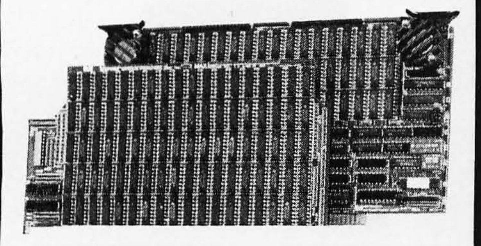
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MACROTECH International Corp.





MACROTECH MAX: 1 SLOT, 1 MEGABYTE!

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Features:

- S-100/IEEE-696 full compatibility
- Various configurations — field upgradeable; 256K - 384K - 512K - and 1 Megabyte!
- High speed — 6MHz in 8 bit environments and 8MHz in 16 bit environments with no wait states
- Under CP/M 2.2®, CP/M 3.0®, CP/M 86® or MP/M II®, all or part of the memory may be devided between system memory and virtual disk
- M3 Memory mapping option for 8-bit environments (Translated 16-bit logical address to 24-bit physical address). Gives Z-80, 8080, or 8085 16 MEG address space
- DMA fully supported in accordance with IEEE/696
- Low power consumption: 4.0 Amps (1 MEG); 3.0 Amps (256K)
- 6 Layer HOST and 4 layer "piggy-back" card for noise-free operation
- Fully socketed — Augut HOLTITE™ zero profile sockets on all ICs

ORDERING INFORMATION: The 256K and 384K versions include the fully socketed Host card. The 512K and larger versions also include the fully socketed "piggy-back" card. To order the M3 Memory Mapping Option, add **M3** to the end of the part number and add $90.00 to the price.

Part Number	Description	Our Price
BVMACMAX256	256K Dynamic RAM (A&T)	$1225.00
BVMACMAX384	384K Dynamic RAM (A&T)	$1467.00
BVMACMAX512	512K Dynamic RAM (A&T)	$1880.00
BVMACMAXM	1MEG Dynamic RAM (A&T)	$2449.00
BVMACMAXTM	MAX Technical Manual	$ 15.00
BVMACMAXVDSK	MAX Virtual Disk Software supplied on 8" S/D Disk	$ 25.00

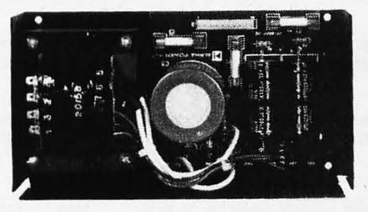
MACROTECH UPGRADE KITS

Each MAX board is ugradeable in 128K increments. Each upgrade includes the RAMs and the proprietary PALs (Programmable Array Logic) required to change the board addressing. Call or write for upgrade kits not listed.

BVMACMKT23	Upgrade from 256K to 384K	$ 265.00
BVMACMKT2M	Upgrade from 256K to 1 MEGABYTE	$1747.00
BVMACMKT3M	Upgrade from 384K to 1 MEGABYTE	$1500.00
BVMACMKT5M	Upgrade from 512K to 1 MEGABYTE	$1005.00

Sierracin/Power Systems





S-100 OPEN FRAME LINEAR SUPPLIES

+ 8V @ 8A ±16V @ 2A — **BVSPL2DS100** (9 lbs.) List: $85.00 — **SALE PRICE $78.00**

+ 8V @ 20A ±16V @ 4A — **BVSPL2FS100** (14 lbs.) List: $140.00 — **SALE PRICE $129.00**

SWITCHING POWER SUPPLY FOR DISK DRIVE APPLICATIONS

200 Watt - 5 Output

5V @ 20A 12V @ 4A -5V @ .7A
+12V @ 4A/7.5A Pk 24V @ 3.2A/6A Pk

BVSPS7M200 (7 lbs.) List Price: $275.00

SALE PRICE: *$249.00*

IBM-PC™ COMPATIBLE COMPUTER SYSTEM





MBC-555

Standard Features Include:

- MS DOS
- 16 bit 8088 CPU
- 128K internal memory
- 1 single sided/double density disk drive (160 Kbytes)
- Color Graphic Capabilities
- Centronic Printer Port
- Diagnostics, Utilities, Speaker & Joystick Port
- Sanyo Basic
- Runs over 80% of IBM-PC™ software
- Word Processing and Spread Sheet Software

BVSYOMBC555 Sanyo IBM-PC™ Compatible Computer (Sh. Wt. 20 lbs.) ***$995.00***

ASK ABOUT OUR SPECIAL PACKAGES INCLUDING SANYO MONITORS!

PRINTERS

MORROW

20 cps LETTER QUALITY

The MORROW DESIGNS **MP200** type daisywheel printer provides all of the features that you would require in a letter quality printer. Features such as 96 character set, 10/12/15 character pitch and proportional spacing, full 13.2" printing width, and a Centronics parallel interface to list just a few, are what makes the MORROW DESIGNS **MP200** your first choice in a low cost letter quality printer.

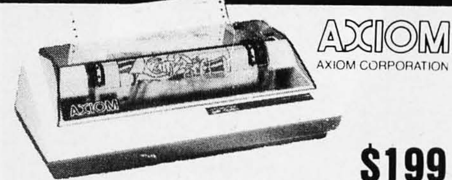
FEATURES:

- 20 cps (Shannon text) print speed - Bi-directional Printing
- 10/12/15 Character pitch and proportional spacing
- 17" paper width paper capacity - 13.2" printing width
- Prints up to 5 part forms
- Front panel controls of PAUSE, LINE FEED, FORM FEED, TOF SET
- POWER, ALERT, and PRINT ON front panel indicators
- Very quiet operation
- Optional tractor feed

Part Number	Description	List price	Our Price
BVMDSMP200	MP200 w/RS232 serial interface (Shipping weight: 35 lbs.)	$950.00	$795.00
BVMDSMPT50TK	MP200 tractor feed		$125.00
	RIBBON CARTRIDGES		
BVSRP5504	Single strike film ribbon		$ 4.95
BVSRP5505	Multistrike ribbon		$ 8.95
	PRINT WHEEL		
BVSRPCOURIER10	Courier 10 pica		$16.95
BVSRPCOURIER12	Courier 12, elite		$16.95
BVSRPMODERN	Proportional type		$16.95
BVSRPSCRIPT	Script elite		$16.95

GEMINI 10X & 15

BVGEM10X	120 cps Parallel Int. 80 col. (20 lbs.)	$319.00
BVGEM15	100 cps Parallel Int. 132 col. (26 lbs.)	$459.00
BVGEMSERINT	Serial interface card for GEM15 (1 lb.)	$85.00
BVGEMSERINTX	Serial interface for GEM10X (1 lb.)	$ 59.00
BVGEMSERINTX4K	Serial interface & 4K buffer for GEM10X	$119.00



$199

OUR LOWEST PRICED PRINTER!

BVAXMGP100A 30 cps 80 col. dot matrix (11 lbs.) **$199.00**

OKIDATA

BVOKIDAT82AT	TRACTOR INCLUDED (25 lbs.)	$449.00
BVOKIDAT83AT	TRACTOR INCLUDED (35 lbs.)	$729.00
BVOKIDAT92AP	OKIDATA 92A Parallel (25 lbs.)	$480.00
BVOKIDAT92AS	OKIDATA92A Serial (25 lbs.)	$599.00
BVOKIDAT92AT	OKIDATA92A Tractor (2 lbs.)	$ 79.95
BVOKIDAT93AP	OKIDATA93A parallel (35 lbs.)	$830.00
BVOKIDAT93AS	OKIDATA93A Serial (35 lbs.)	$995.00

MANNESMANN TALLY

LETTER QUALITY DOT MATRIX PRINTER

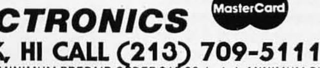
- 160 cps
- 40 cps (Letter quality)
- Serial & Parallel Interface
- Double wide characters
- Tractor and friction feed
- "Bullet-Proof" cast frame with metal cabinet

BVTALMT160L	160 cps 80 col (21 lbs.)	$569.00
BVTALMT180L	160 cps 132 col. (28 lbs.)	$784.00

QUME LETTER QUALITY

BVQMES945	45 cps Sprint 9 serial (49 lbs.)	$1789.00
BVQMES955	55 cps Sprint 9 serial (49 lbs.)	$2195.00
BVQMES1140	40 cps Sprint 11 (45 lbs.)	$1389.00
BVQMES11RS232	RS232 Module for Sprint 11 (3 lbs.)	$ 99.00
BVQMES11CENT	Centronics parallel for Sprint 11 (3 lbs.)	$ 99.00
BVQMES11IEEE488	IEEE488 Module for Sprint 11 (3 lbs.)	$ 99.00
BVQMES11IBM	IBM module for Sprint 11 (3 lbs.)	$ 99.00
BVQMEBDT	Bi-Directional Tractor (9 lbs.)	$ 349.00
BVQMEWB	Wire basket (2 lbs.)	$ 85.00
BVQMECSF	Cut Sheet Feeder (20 lbs.)	$ 849.00

VISA **PRIORITY ONE**



ORDER TOLL FREE (800) 523-5922 - CA, AK, HI CALL (213) 709-5111

Terms. U.S. VISA, MC, BAC, Check, Money Order, U.S. Funds Only. CA residents add 6½% Sales Tax. MINIMUM PREPAID ORDER $15.00. Include MINIMUM SHIPPING & HANDLING of $3.00 for the first 3 lbs. plus 40¢ for each additional pound. Orders over 50 lbs. sent freight collect. Just in case, include your phone number. Prices subject to change without notice. We will do our best to maintain prices through October, 1983. Many quantities are limited. Sorry, no rainchecks, no refunds or exchanges on sale merchandise. Credit Card orders will be charged appropriate freight. Sale prices for prepaid orders only. We are not responsible for typographical errors.

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PRIORITY ONE ELECTRONICS

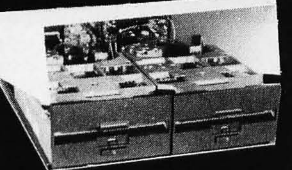
SIEMENS FDD100-8
8" FLOPPY DISK DRIVE
SINGLE SIDED, DOUBLE DENSITY SHUGART 801R COMPATIBLE

90 DAY WARRANTY!!



$175.00 each
$169.00 ea. 2 - 9
10+ CALL
OEM INQUIRIES INVITED
BVSIEFDD1008 (Include $7.00 per drive for shipping)

BUY DRIVE & CABINET TOGETHER AND $AVE!!
DUAL 8" SIEMENS FDD1008
DUAL 8" CABINET POWER SUPPLY
AND INTERNAL POWER CABLES
(Include $30.00 for shipping)

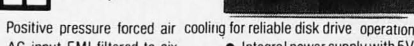


- Positive Pressure Filter Cooling
- Power Supply: 4A@+5V, 3A@+24V 1A @ -5V
- Each output is individually fused
- Hinged to for easy access
- Heavy non-flex .090 aluminum base
- Modular power connectors

IF BOUGHT SEPARATELY: $890.00
SPECIAL SALE PRICE:
$625.00
BVPDBIIISIE (Include $30.00 for shipping)
BVIIIFDE002 CABINET ONLY (Sh. Wt. 38 lbs.) **$295.00**

OUR FINEST DUAL 8" DISK DRIVE CABINET!





- Positive pressure forced air cooling for reliable disk drive operation
- AC input EMI filtered to six amps to help prevent disk crashes due to power spikes and line noise
- Integral power supply with 5V @ 6A/-5V @ 1A/24V @ 6A
- Each DC supply and AC separately fused

Part No.		List Price	Our Price
BVIIIUDE004	(Sh. Wt. 40 lbs.)	$495.00	$349.00

With augmented power supply to handle Tandon Slimline, or Winchester disk drives. Includes the disk environment monitor.

BVIIIUDE004AUG	(Sh. Wt. 40 lbs.)	$733.00	$625.00
BVIIIUDE004EM	(Sh. Wt. 40 lbs.)	$584.95	$395.00

DUAL 5¼" HARD DISK ENCLOSURE
The IIIHD5002 enclosure provides all of the necessary power for two TANDON TM500 series or equivalent hard disk drives, and Xebec Controller. Forced air cooling is provided by a 33 cfm fan, and is filtered to keep your equipment running at its best!



Part Number	Description	List Price	Our Price
BVIIIHD5002	Dual hard disk enclosure	$425.00	$375.00

(Shipping Weight: 20 lbs.)

DISK DRIVES
TANDON 5¼" HARD DISK

BVTNDTM501	1 platter 6 Mbyte (Sh. Wt. 9 lbs.)	$749.00
BVTNDTM502	2 platter 12 Mbyte (Sh. Wt. 9 lbs.)	$895.00
BVTNDTM503	3 platter 19 Mbyte (Sh. Wt. 9 lbs.)	$1049.00

DUAL HARD DISK ENCLOSURE

BUIIIHD5002	For above drives	$395.00

TANDON 5¼"

BVTNDTM1001	1 Sided 48 TPI	$225.00	2 FOR $195.00 each
BVTNDTM1002	2 Sided 48 TPI	$260.00	2 FOR $235.00 each
BVTNDTM1003	1 Sided 96 TPI	$275.00	2 FOR $250.00 each
BVTNDTM1004	2 Sided 96 TPI	$390.00	2 FOR $365.00 each

(Shipping Weights on above items: 5 lbs. each)

MPI 5¼" FULL HEIGHT

BVMPI51*	1 Sided 48 TPI	$200.00
BVMPI52*	2 Sided 48 TPI	$270.00
BVMPI91*	1 Sided 96 TPI	$275.00
BVMPI92*	2 Sided 96 TPI	$400.00

*Replace with an "M" for the MPI style bezel, or with an "S" for Shugart style bezel. (Shipping Weight: 5 lbs.)

MPI 5¼" HALF HEIGHT

BVMPI501	1 Sided 48 TPI (Sh. Wt. 4 lbs.)	$260.00
BVMPI502	2 Sided 48 TPI (Sh. Wt. 4 lbs.)	$300.00
BVMPI901	1 Sided 96 TPI (Sh. Wt. 4 lbs.)	$300.00
BVMPI902	2 Sided 96 TPI (Sh. Wt. 4 lbs.)	$355.00

SHUGART 8" FULL HEIGHT

BVSHU801R	1 sided (18 lbs.)	$369.00

QUME 8" FULL HEIGHT

BVQMEDT8	2 sided (18 lbs.)	$480.00 2 FOR $460.00 each

MITSUBISHI 8" FULL HEIGHT

BVMITM289463B	2 sided (18 lbs.)	$380.00

MPI 8" FULL HEIGHT

BVMPI41S	1 sided (11 lbs.)	$380.00
BVMPI42S	2 sided (11 lbs.)	$460.00

MPI 8" DUAL HALF HEIGHT
(SAME SIZE AS ONE FULL HEIGHT)

BVMPI41D	1 sided (22 lbs.)	$760.00
BVMPI42D	2 sided (22 lbs.)	$870.00

TANDON 8" HALF HEIGHT

BVTNDTM8481	1 sided (9 lbs.)	$395.00 2 FOR $375.00 each
BVTNDTM8482	2 sided (9 lbs.)	$495.00 2 FOR $475.00 each

MPI 8" HALF HEIGHT

BVMPI41M	1 sided (11 lbs.)	$380.00
BVMPI42M	2 sided (11 lbs.)	$460.00

5¼" DRIVE CABINETS

BVJMR1C5	Single 5¼" Cabinet (5 lbs.)	$69.00
BVJMR2C5	Dual 5¼" Cabinet (9 lbs.)	$89.00
BVJMR2C5C	JMR2C5 w/internal data cable (9 lbs.)	$99.00

DUAL 8" HALF HEIGHT FLOPPY CABINET

- 24V @ 4A, 5V @ 3A -5V @ 800ma
- Fan cooled
- Socketed power connections
- All supplies regulated

		List Price	Our Price
BVIIIDTL002	Dual Thin Line Cabinet (12 lbs.)	$225.00	$165.00

BUY THE CABINET & DRIVES AND $AVE!
With 2 Tandon Thinlines

BVIPDBIIITND1	Cabinet w/2 TNDTM8481 - 1 sided (30 lbs.)	$885.00
BVIPDBIIITND2	Cabinet w/2 TNDTM8482 - 2 sided (30 lbs.)	$1115.00

With 2 MPI Slimlines

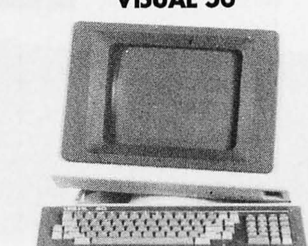
BVPDBIIIMPI1	Cabinet w/2 MPI41M - 1 sided (30 lbs.)	$920.00
BVPDBIIIMPI2	Cabinet w/2 MPI42M - 2 sided (30 lbs.)	$1080.00

Options

BVIIIDTLMPIKIT	MPI drive adaptor mounting kit (2 lbs.)	$24.95
BVIIIDCCSHU	Shugart / AC/DC power connector kit (2 lbs.)	$14.95

(For full size single SA801 or compatible drives)

TERMINALS
VISUAL 50



(Sh. wt.: 41 lbs.)

Part Number	Description	List Price	SALE PRICE
BVVSL50BW	Black & White 12"	$695.00	$625.00
BVVSL50GN	Green Screen 12"	$770.00	$655.00

FEATURE COMPARISON CHART

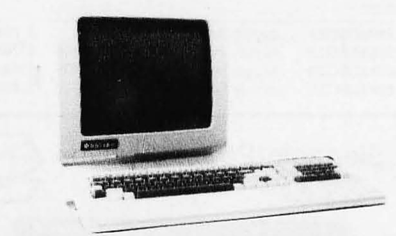
Feature:	VISUAL 50	Hazeltine Esprit	ADDS Viewpoint	Lear Siegler ADM-5	TeleVideo 910
Tilt & Swivel	YES	NO	NO	NO	NO
Detached Keyboard	YES	NO	YES	NO	NO
N-Key Rollover	YES	NO	YES	NO	NO
Audible Key Click	YES	YES	NO	NO	NO
Menu Set-Up Mode	YES	NO	NO	NO	NO
Status Line	YES	NO	NO	NO	NO
Full 5 Attribute Selection	YES	NO	NO	NO	YES
Smooth Scroll	YES	NO	NO	NO	NO
Line Drawing Character Set	YES	NO	NO	NO	NO
Independent RCV/TX Rates	YES	NO	NO	NO	NO
Answerback User Programmable	YES	NO	NO	OPT	NO

VISUAL 330
The VSL330 terminals will emulate the DEC VT52, Data General D200, Lear Siegler ADM-3A, and Hazlitine 1500. Other features include: 12 user programmable function keys, line drawing character set, jump or 2 speed scroll, split screen, full editing, and programmable non-volatile columnar tabbing or field tabbing forward and backward just to name a few.

The VISUAL 300 has all of the same functions as the 330, but does not have multi-emulation. The VISUAL 300 is ANSI X3.64 compatible.

BVVSL300GN	ANSI X3.64, 12" Green	$1095.00	$995.00
BVVSL330GN	Green 12" CRT (Sh. Wt. 41 lbs.)	$1200.00	$895.00
BVVSL33014GN	Green 14" CRT (Sh. WT. 41 lbs.)	$1250.00	$949.00

TELEVIDEO



BVPDBTLV9252P	w/2nd page memory kit FREE (A $95.00 Value)	$729.00
BVPDBTW9504P	w/2nd, 3rd, & 4th page memory kit FREE (A 285.00 Value) (above items: 37 lbs. each)	$929.00
BVTLV910	80 col. terminal (37 lbs.)	$558.95
BVTLV970	14" 80/132 col. terminal (40 lbs.)	$1019.00

LIBERTY ELECTRONICS

BVLIBF50	Freedom 50 (Sh. Wt. 30 lbs.)	$599.00	$474.00

ADDS

BVADDVWPR	Viewpoint 3A+ (30 lbs.)	$695.00	$575.00

QUME



BVQME102	80 Column Green (Sh. Wt. 30 lbs.)	$550.00
BVQME102AM	80 Column Amber (Sh. Wt. 30 lbs.)	$565.00
BVQME103	80/132 Column Green (Sh. Wt. 30 lbs.)	$765.00
BVQME108	22 function key, 80 col. Green (30 lbs.)	$749.00
BVQME108AM	22 function key, 80 col. Amber (30 lbs.)	$765.00

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BV HP-75C	Portable Computer (9 lbs.)	$995.00	**$749.00**
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BV HP00075-15019	Text Formatter		$95.00
BV HP00075-15015	Math Pac		$145.00
BV HP00075-15012	Surveying Pac		$295.00
BV HP00075-15035	DataCommunications Pac		$145.00

HP-41C/CV HANDHELD COMPUTER SYSTEM

BV HP-41C	Handheld computer	$195.00	**$159.00**
BV HP-41CV	Handheld computer w/5x the memory	$275.00	**$219.00**
BV HP82104A	Card reader	$195.00	**$159.00**
BV HP82153A	Optical Wand	$125.00	**$ 99.00**
BV HP82161A	Cassette drive	$450.00	**$349.00**
BV HP82162A	Thermal Printer	$450.00	**$349.00**
BV HP82163A	Video Interface	$225.00	**$179.00**

(Shipping Weights on above items: 5 lbs. each)

ENHANCEMENT MODULES:

BV HP82160A	HP-IL module	$125.00	**$95.00**
BV HP82170A	Quad RAM module	$ 75.00	**$59.00**
BV HP82180A	Extended functions/ memory module	$ 75.00	**$59.00**
BV HP82181A	Ext. memory module	$ 75.00	**$59.00**
BV HP82182A	Time module	$ 75.00	**$59.00**

(Shipping Weights on above items: 1 lb. each)

We now carry the complete line of series 40 Application Pacs and Solution Books

HP-IL PERIPHERALS
For HP-41CV & HP-75C

Part No.	Description	List Price	Our Price
BV HP82160A	HP-IL Interface included in HP-75C	$125.00	$ 99.00
BV HP82161A	Digital Cassette Drive	$450.00	$349.00
BV HP82176A	Digital Cassettes (10 pack)		$ 95.00
BV HP82162A	Thermal Printer/Plotter	$450.00	$349.00
BV HP82125A	Thermal Printer Paper (6 rolls)		$ 10.00
BV HP82163A	Video Interface	$225.00	$179.00
BV HP82164A	RS-232 Serial Interface	$295.00	$249.00
BV HP82165A	GP10 Interface	$295.00	$249.00

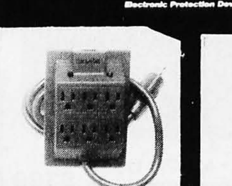
SERIES 10 PROGRAMMABLE CALCULATORS

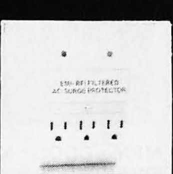
BV HP-10C	Scientific	$ 70.00	**$59.00**
BV HP-11C	Adv. scientific	$ 90.00	**$79.00**
BV HP-12C	Adv. financial	$120.00	**$99.00**
BV HP-15C	Adv. sci. w/matrix	$120.00	**$99.00**
BV HP-16C	Digital & Computer science	$120.00	**$99.00**

(Shipping Weights on above calculators: 3 lbs. each)

AC SURGE PROTECTORS FOR YOUR COMPUTER

EPD Electronic Protection Devices





THE LEMON™ SOURS SURGES

Part No.	Description	List Price	Our Price
BVEPDLEMON	6 outlet wall mount	$59.95	**$44.95**
BVEPDLIME	6 outlet 4½" cord w/power switch	89.50	**$69.95**

(Shipping Weight: 4 lbs. each)

EMI-RFI FILTERED AC SURGE PROTECTOR

BVEPDORANGE	6 outlet 4½" cord w/power switch	$139.95	**$104.95**
BVEPDPEACH	6 outlet wall mount	$97.50	**$ 74.95**

(Shipping Weight: 4 lbs. each)

1200 BAUD MODEM SALE!

U.S. ROBOTICS



PASSWORD 1200 BAUD Auto Originate/ Auto Answer $379

Part Number	Description	List Price	Our Price
BVPDBPASSTEL8	Password Modem w/Communication Software 8" CP/M®	$528.00	**$379.00**
BVPDBPASSTEL5	Password Modem w/Communication Software 5¼" Apple	$528.00	**$379.00**
BVPDBADIALTEL8	Auto Dial 212A Modem w/Communication software 8" CP/M®	$678.00	**$495.00**
BVPDBADIALTEL5	Auto Dial 212A Modem w/Communication software 5¼" Apple	$678.00	**$495.00**

RIXON



1200 BAUD AUTO DIAL

DIRECT CONNECT MODEMS WITH 10 NUMBER MEMORY

Part Number	Description	List Price	Our Price
BVRIXR212A	1200 Baud Stand Alone unit	$495.00	**$475.00**
BVRIXPC212A	1200 IBM PC™ modem (2 lbs.)	$495.00	**$475.00**
BVRIXPCCOM1	IBM PC™ Modem Software (1 lb.)		**$ 89.00**
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D.C. HAYES

BVDCH0400P	1200 Baud Smartmodem	$695.00	**$514.95**
BVDCH0200P	300 Baud Smartmodem	$279.00	**$229.00**
BVDCH0300P	Chronograph	$249.00	**$199.00**
BVDCH0100P	MicroModem 100	$399.00	**$349.00**
BVDCH0000P	MicroModem II	$379.00	**$299.00**

MURA 300 BAUD DIRECT CONNECT

- RS232 C Interface
- Full Duplex
- Bell 103 compatible

$79.00

		List Price	OUR PRICE
BVMURMM100	0-300 baud modem (2 lbs.)	$99.55.	**$79.00**
BVCNDRS2328F	RS232 Cable		$19.95

INTRODUCING THE LOW COST FLUKE 70 SERIES DMM!

- Analog Bar Graph
- 3200 Count LCD Display
- Fast, Autoranging
- Simple, Single Knob Operation
- Resistance to 32M
- 2000 Hour Battery Life
- Diode Test
- VDE, UL Listed

3 Models/3 Basic Accuracies

BVFLU73	0.7% Accuracy	**$85.00**
BVFLU75	0.5% Accuracy	**$99.00**
BVFLU77	0.3% Accuracy	**$129.00**

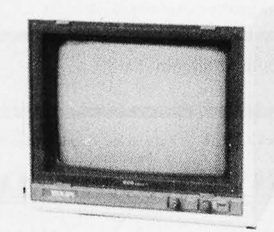
(Shipping weights: 5 lbs. each)

BVFLUC70	Vinyl Case	$ 9.00
BVFLUC71	Holster	$ 9.00

(Included with FLU77)

12" RGB COLOR VIDEO MONIOTRS

TAXAN



Part No.	Description	List Price	Our Price
BVTAXRGB1	Medium Resolution/310 lines	$399.00	$379.00
BVTAXRGB3	Super High Res/630 lines	$699.00	$659.00

Shipping Weight 30lbs.

INTERFACE BOARDS AND CABLES

BVTAXAPPLE2RGB	RGB interface for Apple II	$149.00	$139.00
BVTAX410-80	RGB 80 col int. for Apple IIe	$199.00	$185.00
BVTAXIBMRGB	RGB cable for IBM PC		$19.00
BVTAXRGBAPL	RGB cable for Apple IIe and III		$19.00

Shipping weight: 1 lb on each

5¼" FLOPPY DISKETTES

ULTRA MAGNETICS

DOUBLE DENSITY! LIFETIME WARRANTY!

FEATURES:
- Includes reinforcement ring
- 100% Surface tested
- Write protect with tabs
- Lifetime warranty!

SINGLE SIDED

40 TRACKS — DOUBLE DENSITY

1 BOX OF 10:	**$ 25.00**
2 BOXES:	**$ 40.00**
10 BOXES:	**$180.00**

ORDERING INFORMATION

BVULT51401	Soft Sector
BVULT51410	10 Sector
BVULT51416	16 Sector

BVULT52401	Soft sector, 40 track, 2 sided
BVULT52410	10 sector, 40 track, 2 sided
BVULT52416	16 sector, 40 track, 2 sided

1 BOX OF 10	2 BOXES	10 BOXES
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VOLTAGE REGULATOR
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Z80A-CPU	3.95
Z80A-CTC	3.95
Z80A-PIO	3.95
Z80A-SIO/1	12.95
Z80A-DART	6.95
8086 16-BIT 5MHZ	19.95
68A00 CPU 1.5MHZ	2.95
68A10 RAM 1.5MHZ	1.95
68A21 PIA 1.5MHZ	2.95
68A50 ACIA 1.5MHZ	2.95
6520/6820 PIA	2.95

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2111L	450NS-LP	1.49
2112	450NS	1.99
2114	450NS	.99
2114-25	250NS	1.09
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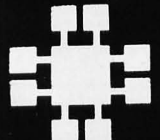
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DP8350	19.95
CRT5027	9.95
CRT5037	9.95

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4164 64K DYNAMIC 200 NS $5.95

TMM2016 2KX8 STATIC 200 NS $4.15

STATIC RAMS

Part	Organization	Specs	Price
2101	256 x 4	(450ns)	1.95
5101	256 x 4	(450ns) (cmos)	3.95
2102-1	1024 x 1	(450ns)	.89
2102L-4	1024 x 1	(450ns) (LP)	.99
2102L-2	1024 x 1	(250ns) (LP)	1.49
2111	256 x 4	(450ns)	2.49
2112	256 x 4	(450ns)	2.99
2114	1024 x 4	(450ns)	8/9.95
2114-25	1024 x 4	(250ns)	8/10.95
2114L-4	1024 x 4	(450ns) (LP)	8/12.95
2114L-3	1024 x 4	(300ns) (LP)	8/13.45
2114L-2	1024 x 4	(200ns) (LP)	8/13.95
2147	4096 x 1	(55ns)	4.95
TMS4044-4	4096 x 1	(450ns)	3.49
TMS4044-3	4096 x 1	(300ns)	3.99
TMS4044-2	4096 x 1	(200ns)	4.49
MK4118	1024 x 8	(250ns)	9.95
TMM2016-200	2048 x 8	(200ns)	4.15
TMM2016-150	2048 x 8	(150ns)	4.95
TMM2016-100	2048 x 8	(100ns)	6.15
HM6116-4	2048 x 8	(200ns) (cmos)	4.75
HM6116-3	2048 x 8	(150ns) (cmos)	4.95
HM6116-2	2048 x 8	(120ns) (cmos)	8.95
HM6116LP-4	2048 x 8	(200ns) (cmos)(LP)	5.95
HM6116LP-3	2048 x 8	(150ns) (cmos)(LP)	6.95
HM6116LP-2	2048 x 8	(120ns) (cmos)(LP)	10.95
Z-6132	4096 x 8	(300ns) (Qstat)	34.95

LP = Low Power   Qstat = Quasi-Static

DYNAMIC RAMS

Part	Organization	Specs	Price
TMS4027	4096 x 1	(250ns)	1.99
UPD411	4096 x 1	(300ns)	3.00
MM5280	4096 x 1	(300ns)	3.00
MK4108	8192 x 1	(200ns)	1.95
MM5298	8192 x 1	(250ns)	1.85
4116-300	16384 x 1	(300ns)	8/11.75
4116-250	16384 x 1	(250ns)	8/11.95
4116-200	16384 x 1	(200ns)	8/12.95
4116-150	16384 x 1	(150ns)	8/14.95
4116-120	16384 x 1	(120ns)	8/29.95
2118	16384 x 1	(150ns) (5v)	4.95
4164-200	65536 x 1	(200ns) (5v)	5.95
4164-150	65536 x 1	(150ns) (5v)	6.95

5V = single 5 volt supply

EPROMS

Part	Organization	Specs	Price
1702	256 x 8	(1us)	4.50
2708	1024 x 8	(450ns)	3.95
2758	1024 x 8	(450ns) (5v)	5.95
2716	2048 x 8	(450ns) (5v)	3.95
2716-1	2048 x 8	(350ns) (5v)	5.95
TMS2516	2048 x 8	(450ns) (5v)	5.50
TMS2716	2048 x 8	(450ns)	7.95
TMS2532	4096 x 8	(450ns) (5v)	5.95
2732	4096 x 8	(450ns) (5v)	4.95
2732-250	4096 x 8	(250ns) (5v)	8.95
2732-200	4096 x 8	(200ns) (5v)	11.95
2764	8192 x 8	(450ns) (5v)	9.95
2764-250	8192 x 8	(250ns) (5v)	14.95
2764-200	8192 x 8	(200ns) (5v)	24.95
TMS2564	8192 x 8	(450ns) (5v)	17.95
MC68764	8192 x 8	(450ns) (5v)(24 pin)	39.95
27128	16384x8	Call	Call

5v = Single 5 Volt Supply

EPROM ERASERS

	Timer	Capacity Chip	Intensity (uW/Cm²)	
PE-14		6	5,200	83.00
PE-14T	X	6	5,200	119.00
PE-24T	X	9	6,700	175.00
PL-265T	X	20	6,700	255.00
PR-125T	X	16	15,000	349.00
PR-320	X	32	15,000	595.00

Z-80

2.5 Mhz	
Z80-CPU	3.95
Z80-CTC	4.49
Z80-DART	10.95
Z80-DMA	14.95
Z80-PIO	4.49
Z80-SIO/0	16.95
Z80-SIO/1	16.95
Z80-SIO/2	16.95
Z80-SIO/9	16.95
4.0 Mhz	
Z80A-CPU	4.95
Z80A-CTC	4.95
Z80A-DART	11.95
Z80A-DMA	16.95
Z80A-PIO	4.95
Z80A-SIO/0	16.95
Z80A-SIO/1	16.95
Z80A-SIO/2	16.95
Z80A-SIO/9	16.95
6.0 Mhz	
Z80B-CPU	11.95
Z80B-CTC	13.95
Z80B-PIO	13.95
Z80B-DART	19.95
ZILOG	
Z6132	34.95
Z8671	39.95

CRYSTALS

32.768 khz	1.95
1.0 mhz	4.95
1.8432	4.95
2.0	3.95
2.097152	3.95
2.4576	3.95
3.2768	3.95
3.579535	3.95
4.0	3.95
5.0	3.95
5.0688	3.95
5.185	3.95
5.7143	3.95
6.0	3.95
6.144	3.95
6.5536	3.95
8.0	3.95
10.0	3.95
10.738635	3.95
14.31818	3.95
15.0	3.95
16.0	3.95
17.430	3.95
18.0	3.95
18.432	3.95
20.0	3.95
22.1184	3.95
32.0	3.95

CRT CONTROLLERS

6845	14.95
68B45	19.95
HD46505SP	15.95
6847	11.95
MC1372	6.95
68047	24.95
8275	29.95
7220	99.95
CRT5027	39.95
CRT5037	49.95
TMS9918A	39.95
DP8350	49.95

KEYBOARD CHIPS

AY5-2376	11.95
AY5-3600	11.95
AY5-3600 PRO	11.95

8000

8035	5.95
8039	6.95
INS-8060	17.95
INS-8073	24.95
8080	3.95
8085	5.95
8085A-2	11.95
8086	29.95
8087	CALL
8088	39.95
8089	89.95
8155	6.95
8155-2	7.95
8156	6.95
8185	29.95
8185-2	39.95
8741	39.95
8748	24.95
8755	24.95

8200

8202	24.95
8203	39.95
8205	3.50
8212	1.80
8214	3.85
8216	1.75
8224	2.25
8226	1.80
8228	3.49
8237	19.95
8237-5	21.95
8238	4.49
8243	4.45
8250	10.95
8251	4.49
8253	6.95
8253-5	7.95
8255	4.49
8255-5	5.25
8257	7.95
8257-5	8.95
8259	6.90
8259-5	7.50
8271	39.95
8272	39.95
8275	29.95
8279	8.95
8279-5	10.00
8282	6.50
8283	6.50
8284	5.50
8286	6.50
8287	6.50
8288	25.00
8289	49.95

DISC CONTROLLERS

1771	16.95
1791	24.95
1793	26.95
1795	49.95
1797	49.95
2791	54.95
2793	54.95
2795	59.95
2797	59.95
6843	34.95
8272	39.95
UPD765	39.95
MB8876	29.95
MB8877	34.95
1691	17.95
2143	18.95

CONNECTORS

RS232 MALE	2.50
RS232 FEMALE	3.25
RS232 HOOD	1.25
S-100 ST	3.95

6800

68000	59.95
6800	3.95
6802	7.95
6808	13.90
6809E	19.95
6809	11.95
6810	2.95
6820	4.35
6821	3.25
6828	14.95
6840	12.95
6843	34.95
6844	25.95
6845	14.95
6847	11.95
6850	3.25
6852	5.75
6860	9.95
6862	11.95
6875	6.95
6880	2.25
6883	22.95
68047	24.95
68488	19.95
6800 = 1MHZ	
68B00	10.95
68B02	22.25
68B09E	29.95
68B09	29.95
68B10	6.95
68B21	6.95
68B45	19.95
68B50	5.95
68B00 = 2 MHZ	

6500

1 MHZ	
6502	4.95
6504	6.95
6505	8.95
6507	9.95
6520	4.35
6522	7.95
6532	9.95
6545	22.50
6551	11.85
2 MHZ	
6502A	6.95
6522A	9.95
6532A	11.95
6545A	27.95
6551A	11.95
3 MHZ	
6502B	14.95

UARTS

AY3-1014	6.95
AY5-1013	3.95
AY3-1015	6.95
PT1472	9.95
TR1602	3.95
2350	9.95
2651	8.95
TMS6011	5.95
IM6402	7.95
IM6403	8.95
INS8250	10.95

GENERATORS

BIT-RATE	
MC14411	11.95
BR1941	11.95
4702	12.95
COM5016	16.95
COM8116	10.95
MM5307	10.95
FUNCTION	
MC4024	3.95
LM566	1.49
XR2206	3.75
8038	3.95

74LS00

74LS00	.24	74LS173	.69
74LS01	.25	74LS174	.55
74LS02	.25	74LS175	.55
74LS03	.25	74LS181	2.15
74LS04	.24	74LS189	8.95
74LS05	.25	74LS190	.89
74LS08	.28	74LS191	.89
74LS09	.29	74LS192	.79
74LS10	.25	74LS193	.79
74LS11	.35	74LS194	.69
74LS12	.35	74LS195	.69
74LS13	.45	74LS196	.79
74LS14	.59	74LS197	.79
74LS15	.35	74LS221	.89
74LS20	.25	74LS240	.95
74LS21	.29	74LS241	.99
74LS22	.25	74LS242	.99
74LS26	.29	74LS243	.99
74LS27	.29	74LS244	1.29
74LS28	.35	74LS245	1.49
74LS30	.25	74LS247	.75
74LS32	.29	74LS248	.99
74LS33	.55	74LS249	.99
74LS37	.35	74LS251	.59
74LS38	.35	74LS253	.59
74LS40	.25	74LS257	.59
74LS42	.49	74LS258	.59
74LS47	.75	74LS259	2.75
74LS48	.75	74LS260	.59
74LS49	.75	74LS266	.55
74LS51	.25	74LS273	1.49
74LS54	.29	74LS275	3.35
74LS55	.29	74LS279	.49
74LS63	1.25	74LS280	1.98
74LS73	.39	74LS283	.69
74LS74	.35	74LS290	.89
74LS75	.39	74LS293	.89
74LS76	.39	74LS295	.99
74LS78	.49	74LS298	.89
74LS83	.60	74LS299	1.75
74LS85	.69	74LS323	3.50
74LS86	.39	74LS324	1.75
74LS90	.55	74LS352	1.29
74LS91	.89	74LS353	1.29
74LS92	.55	74LS363	1.35
74LS93	.55	74LS364	1.95
74LS95	.75	74LS365	.49
74LS96	.89	74LS366	.49
74LS107	.39	74LS367	.45
74LS109	.39	74LS368	.45
74LS112	.39	74LS373	1.39
74LS113	.39	74LS374	1.39
74LS114	.39	74LS377	1.39
74LS122	.45	74LS378	1.18
74LS123	.79	74LS379	1.35
74LS124	2.90	74LS385	1.90
74LS125	.49	74LS386	.45
74LS126	.49	74LS390	1.19
74LS132	.59	74LS393	1.19
74LS133	.59	74LS395	1.19
74LS136	.39	74LS399	1.49
74LS137	.99	74LS424	2.95
74LS138	.55	74LS447	.37
74LS139	.55	74LS490	1.95
74LS145	1.20	74LS624	3.99
74LS147	2.49	74LS640	2.20
74LS148	1.35	74LS645	2.20
74LS151	.55	74LS668	1.69
74LS153	.55	74LS669	1.89
74LS154	1.90	74LS670	1.49
74LS155	.69	74LS674	9.65
74LS156	.69	74LS682	3.20
74LS157	.65	74LS683	3.20
74LS158	.59	74LS684	3.20
74LS160	.69	74LS685	3.20
74LS161	.65	74LS688	2.40
74LS162	.69	74LS689	3.20
74LS163	.65	74LS783	24.95
74LS164	.69	81LS95	1.49
74LS165	.95	81LS96	1.49
74LS166	1.95	81LS97	1.49
74LS168	1.75	81LS98	1.49
74LS169	1.75	25LS2521	2.80
74LS170	1.49	25LS2569	4.25

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Circle 247 on inquiry card.

2114 450 NS 8/$9.95 — 2114 250 NS 8/$10.95

7400

'400	.19	74132	.45
'401	.19	74136	.50
'402	.19	74141	.65
'403	.19	74142	2.95
7404	.19	74143	2.95
7405	.25	74145	.60
7406	.29	74147	1.75
7407	.29	74148	1.20
7408	.24	74150	1.35
7409	.19	74151	.55
7410	.19	74152	.65
'411	.25	74153	.55
7412	.30	74154	1.25
7413	.35	74155	.75
7414	.49	74156	.65
7416	.25	74157	.55
7417	.25	74159	1.65
7420	.19	74160	.85
7421	.35	74161	.69
7422	.35	74162	.85
7423	.29	74163	.69
7425	.29	74164	.85
7426	.29	74165	.85
7427	.29	74166	1.00
7428	.45	74167	2.95
7430	.19	74170	1.65
7432	.29	74172	5.95
7433	.45	74173	.75
7437	.29	74174	.89
7438	.29	74175	.89
7440	.19	74176	.89
7442	.49	74177	.75
7443	.65	74178	1.15
7444	.69	74179	1.75
7445	.69	74180	.75
7446	.69	74181	2.25
7447	.69	74182	.75
7448	.69	74184	2.00
7450	.19	74185	2.00
7451	.23	74190	1.15
7453	.23	74191	1.15
7454	.23	74192	.79
7460	.23	74193	.79
7470	.35	74194	.85
7472	.29	74195	.85
7473	.34	74196	.79
7474	.33	74197	.75
7475	.45	74198	1.35
7476	.35	74199	1.35
7480	.59	74221	1.35
7481	1.10	74246	1.35
7482	.95	74247	1.25
7483	.50	74248	1.85
7485	.59	74249	1.95
7486	.35	74251	.75
7489	2.15	74259	2.25
7490	.35	74265	1.35
7491	.40	74273	1.95
7492	.50	74276	1.25
7493	.35	74279	.75
7494	.65	74283	2.00
7495	.55	74284	3.75
7496	.70	74285	3.75
7497	2.75	74290	.95
74100	1.75	74293	.75
74107	.30	74298	.85
74109	.45	74351	2.25
74110	.45	74365	.65
74111	.55	74366	.65
74116	1.55	74367	.65
74120	1.20	74368	.65
74121	.29	74376	2.20
74122	.45	74390	1.75
74123	.49	74393	1.35
74125	.45	74425	3.15
74126	.45	74426	.85
74128	.55	74490	2.55

LINEAR

LM301	.34	LM340 (see 7800)		LM566	1.49	LM1800	2.37
LM301H	.79	LM348	.99	LM567	.89	LM1812	8.25
LM307	.45	LM350K	4.95	NE570	3.95	LM1830	3.50
LM308	.69	LM350T	4.60	NE571	2.95	LM1871	5.49
LM308H	1.15	LM358	.69	NE592	2.75	LM1872	5.49
LM309H	1.95	LM359	1.79	LM709	.59	LM1877	3.25
LM309K	1.25	LM376	3.75	LM710	.75	LM1889	1.95
LM310	1.75	LM377	1.95	LM711	.79	LM1896	1.75
LM311	.64	LM378	2.50	LM723	.49	ULN2003	2.49
LM311H	.89	LM379	4.50	LM723H	.55	LM2877	2.05
LM312H	1.75	LM380	.89	LM733	.98	LM2878	2.25
LM317K	3.95	LM380N-8	1.10	LM741	.35	LM2900	.85
LM317T	1.19	LM381	1.60	LM741N-14	.35	LM2901	1.00
LM318	1.49	LM382	1.60	LM741H	.40	LM3900	.59
LM318H	1.59	LM383	1.95	LM747	.69	LM3905	1.25
LM319H	1.90	LM384	1.95	LM748	.59	LM3909	.98
LM319	1.25	LM386	.89	LM1014	1.19	LM3911	2.25
LM320 (see 7900)		LM387	1.40	LM1303	1.95	LM3914	3.95
LM322	1.65	LM389	1.35	LM1310	1.49	LM3915	3.95
LM323K	4.95	LM390	1.95	MC1330	1.69	LM3916	3.95
LM324	.59	LM392	.69	MC1349	1.89	MC4024	3.95
LM329	.65	LM394H	4.60	MC1350	1.19	MC4044	4.50
LM331	3.95	LM399H	5.00	MC1358	1.69	RC4136	1.25
LM334	1.19	NE531	2.95	MC1372	6.95	RC4151	3.95
LM335	1.40	NE555	.34	LM1414	1.59	LM4250	1.75
LM336	1.75	NE556	.65	LM1458	.59	LM4500	3.25
LM337K	3.95	NE558	1.50	LM1488	.69	RC4558	.69
LM337T	1.95	NE561	24.95	LM1489	.69	LM13080	1.29
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LM339	.99	LM565	.99	LM1558H	3.10	LM13700	1.49

H = TO-5 CAN T = TO-220 K = TO-3

RCA

CA 3023	2.75	CA 3082	1.65
CA 3039	1.29	CA 3083	1.55
CA 3046	1.25	CA 3086	.80
CA 3059	2.90	CA 3089	2.99
CA 3060	2.90	CA 3096	3.49
CA 3065	1.75	CA 3130	1.30
CA 3080	1.10	CA 3140	1.15
CA 3081	1.65	CA 3146	1.85
CA 3160	1.19		

TI

TL494	4.20	75365	1.95
TL496	1.65	75450	.59
TL497	3.25	75451	.39
75107	1.49	75452	.39
75110	1.95	75453	.39
75150	1.95	75454	.39
75154	1.95	75491	.79
75188	1.25	75492	.79
75189	1.25	75493	.89
75494	.89		

BI FET

TL071	.79	TL084	2.19
TL072	1.19	LF347	2.19
TL074	2.19	LF351	.60
TL081	.79	LF353	1.00
TL082	1.19	LF355	1.10
TL083	1.19	LF356	1.10
LF357	1.40		

CMOS

4000	.29	4527	1.95
4001	.25	4528	1.19
4002	.25	4531	.95
4006	.89	4532	1.95
4007	.29	4538	1.95
4008	.95	4539	1.95
4009	.39	4541	2.64
4010	.45	4543	1.19
4011	.25	4553	5.79
4012	.25	4555	.95
4013	.38	4556	.95
4014	.79	4581	1.95
4015	.39	4582	1.95
4016	.39	4584	.75
4017	.69	4585	.75
4018	.79	4702	12.95
4019	.39	74C00	.35
4020	.75	74C02	.35
4021	.79	74C04	.35
4022	.79	74C08	.35
4023	.29	74C10	.35
4024	.65	74C14	.59
4025	.29	74C20	.35
4026	1.65	74C30	.35
4027	.45	74C32	.39
4028	.69	74C42	1.29
4029	.79	74C48	1.99
4030	.39	74C73	.65
4034	1.95	74C74	.65
4035	.85	74C76	.80
4040	.75	74C83	1.95
4041	.75	74C85	1.95
4042	.69	74C86	.39
4043	.85	74C89	4.50
4044	.79	74C90	1.19
4046	.85	74C93	1.75
4047	.95	74C95	.99
4049	.35	74C107	.89
4050	.35	74C150	5.75
4051	.79	74C151	2.25
4053	.79	74C154	3.25
4060	.89	74C157	1.75
4066	.39	74C160	1.19
4068	.39	74C161	1.19
4069	.29	74C162	1.19
4070	.35	74C163	1.19
4071	.29	74C164	1.39
4072	.29	74C165	2.00
4073	.29	74C173	.79
4075	.29	74C174	1.19
4076	.79	74C175	1.19
4078	.29	74C192	1.49
4081	.29	74C193	1.49
4082	.29	74C195	1.39
4085	.95	74C200	5.75
4086	.95	74C221	1.75
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7815T	.75	7924T	.85
7824T	.75		
		7905K	1.49
7805K	1.39	7912K	1.49
7812K	1.39	7915K	1.49
7815K	1.39	7924K	1.49
7824K	1.39		
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78L12	.69	79L12	.79
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L = TO-92

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.27						.40	
.33						.40	.45
.47				.35			.50
.68						.45	.50
1.0			.40	.40	.45	.45	
1.5				.45		.50	.60
1.8							.75
2.2		.35	.40	.45		.65	.85
2.7		.40	.45				.90
3.3		.45	.50	.55	.60	.65	.90
3.9		.45					
4.7	.45	.55		.60	.65	.85	.90
6.8			.70		.75		
8.2							1.00
10	.55	.65	.80	.85	.90	1.00	
12	.65		.85	.90			
15	.75	.85	.90				
18			1.25				
22		1.00	1.35				
27			2.25				
39		1.50					
47	1.35						
56	1.75						
100		3.25					
270	3.75						

DISC

10pf	50V	.05	470	50V	.05
22	50V	.05	560	50V	.05
25	50V	.05	680	50V	.05
27	50V	.05	820	50V	.05
33	50V	.05	.001uf	50V	.05
47	50V	.05	.0015	50V	.05
56	50V	.05	.0022	50V	.05
68	50V	.05	.005	50V	.05
82	50V	.05	.01	50V	.07
100	50V	.05	.02	50V	.07
220	50V	.05	.05	50V	.07
330	50V	.05	.1	12V	.10
			.1	50V	.12

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.1uf-mono 50V .18 .47uf-mono 50V .25

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RADIAL			AXIAL		
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1	25V	.14	4.7	16V	.14
2.2	35V	.15	10	16V	.14
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10	50V	.15	22	16V	.14
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24 pin ST	.30	.27
28 pin ST	.40	.32
40 pin ST	.49	.39
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2N3414	.25	2N5209	.25
2N3563	.40	2N6028	.35
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12.6VAC CT	2amp	5.95
12.6VAC CT	4amp	7.95
12.6VAC CT	8amp	10.95
25.2VAC CT	2amp	7.95

PLUG CASE STYLE

12VAC	250ma	3.95
12VAC	500ma	4.95
12VAC	1amp	5.95
12VAC	2amp	6.95

DC ADAPATER

6, 9, 12 VDC selectable with universal adapter 8.95

NOTE: Please include sufficient amount for shipping on above items.

DIP CONNECTORS

DESCRIPTION	HIGH RELIABILITY TOOLED ST IC SOCKETS	COMPONENT CARRIERS (DIP HEADERS)	RIBBON CABLE DIP PLUGS (IDC)
ORDER BY	AUGATxx-ST	ICCxx	IDPxx
CONTACTS 8	.99	.65	
14	.99	.75	1.45
16	.99	.85	1.65
18	1.69	1.00	
20	1.89	1.25	
22	1.89	1.25	
24	1.99	1.35	2.50
28	2.49	1.50	
40	2.99	2.10	4.15

For order instructions see "IDC Connectors" below.

POWER SUPPLY MODEL 2 $39.95

MOUNTED ON PC BOARD
MANUFACTURED BY CONVER
+5 VOLT 4 AMP
±12 VOLT 1 AMP

NOTE: Please include sufficient amount for shipping on above items.

CENTRONICS

IDCEN36	Ribbon Cable	36 Pin Male	8.95
CEN36	Solder Cup	36 Pin Male	7.95

RIBBON CABLE

CONTACTS	SINGLE COLOR 1'	SINGLE COLOR 10'	COLOR CODED 1'	COLOR CODED 10'
10	.50	4.40	.83	7.30
16	.55	4.80	1.00	8.80
20	.65	5.70	1.25	11.00
25	.75	6.60	1.32	11.60
26	.75	6.60	1.32	11.60
34	.98	8.60	1.65	14.50
40	1.32	11.60	1.92	16.80
50	1.38	12.10	2.50	22.00

D-SUBMINIATURE

DESCRIPTION	SOLDER CUP MALE	SOLDER CUP FEMALE	RIGHT ANGLE PC SOLDER MALE	RIGHT ANGLE PC SOLDER FEMALE	IDC RIBBON CABLE MALE	IDC RIBBON CABLE FEMALE	HOODS BLACK	HOODS GREY
ORDER BY	DBxxP	DBxxS	DBxxPR	DBxxSR	IDBxxP	IDBxxS	HOOD-B	HOOD
CONTACTS 9	2.08	2.66	1.65	2.18	3.37	3.69	---	1.60
15	2.69	3.63	2.20	3.03	4.70	5.13	---	1.60
25	2.50	3.25	3.00	4.42	6.23	6.84	1.25	1.25
37	4.80	7.11	4.83	6.19	9.22	10.08	---	2.95
50	6.06	9.24	---	---	---	---	---	3.50

For order instructions see "IDC Connectors" below.

CALL FOR MOUNTING HARDWARE

IDC CONNECTORS

DESCRIPTION	SOLDER HEADER	RIGHT ANGLE SOLDER HEADER	WW HEADER	RIGHT ANGLE WW HEADER	RIBBON HEADER SOCKET	RIBBON HEADER	RIBBON EDGE CARD
ORDER BY	IDHxxS	IDHxxSR	IDHxxW	IDHxxWR	IDSxx	IDMxx	IDExx
CONTACTS 10	.82	.85	1.86	2.05	1.15	---	2.25
20	1.29	1.35	2.98	3.28	1.86	5.50	2.36
26	1.68	1.76	3.84	4.22	2.43	6.25	2.65
34	2.20	2.31	4.50	4.45	3.15	7.00	3.25
40	2.58	2.72	5.28	4.80	3.73	7.50	3.80
50	3.24	3.39	6.63	7.30	4.65	8.50	4.74

ORDERING INSTRUCTIONS: Insert the number of contacts in the position marked "**xx**" of the "order by" part number listed. **Example:** A 10 pin right angle solder style header would be IDH**10**SR.

Circle 248 on inquiry card.

Unclassified Ads

WANTED: Get a tax deduction instead of a cash loss when you sell your equipment. I can put you in touch with nonprofit organizations that need your donated equipment and can give you a tax receipt. Rev. Edw. Simpson, POB 931, Columbia, MD 21044, (301) 997-4992.

NEEDED: A network 2 controller, two printers, 16 nondisk student station/terminals, and modem to supplement a TRS-80 Model I. Group of educators plans to teach computer literacy in a low-income community. All contributions are tax deductible. Dr. Sidney Rabsatt, 1122 Banbury Cross, Arondale Esates, GA 30002, (404) 292-8366.

WANTED: A nonprofit agency that serves mentally retarded adults seeks tax-deductible donations of computers, modems, printers, and terminals. Certified receipts will be furnished. Winifred Law Opportunity Center Inc., 106 East Second, POB 434, Indianola, IA 50125, (515) 961-5341; call collect, ask for Alan or Ron.

WANTED: Nonprofit educational research organization seeks donation of tax-deductible personal computer (Apple) for record keeping. Greater Milwaukee Chapter of Ileitis and Colitis, 626 East Wisconsin Ave., Milwaukee, WI 53213, (414) 291-6980.

WANTED: Tax-exempt nonprofit whale-research organization needs functional hardware and/or software in data and word processing with 64K potential, and printing/accounting capabilities. Our references and IRS information available on request. Frederick Wenzel, Director of Operations, Mingan Island Cetacean Study Inc., POB 518, Meriden, CT 06450.

WANTED: Church seeks Apple II Plus equipment for use in Christian education program. All donations are tax deductible. Rev. Jay van Santen, First Presbyterian Church, 609 Southeast Second St., Evansville, IN 47713.

WANTED: Commodore 64- or VIC 20-compatible software to use in computer literacy/programming classes and tutorial studies in private Christian school. All donations are tax deductible. Rodney Cain, Faith Academy, 4700 South Main, Rockford, IL 61102, (815) 964-0133.

WANTED: A donation of a computer for use in bulk mail and records of nonprofit organization and OSI C8P DF with interface to control 8 stepping motor animation stand. Also, information about fund raising by computer mailing list for Christians and Jews. Dan Coffin, Aim for Christ, 654 Kennebec Ave., Takoma Park, MD 20912.

FOR SALE: Lots of hardware/software: Apple, Commodore, Zenith. Also, disk packs, modems, chips, disks, cables, cable parts, ribbons, and so on. Much is brand new. Selling at auction. Send SASE for catalog. Will consider donating all or part to worthwhile IRS-approved charity. Edwin F. Schaeffer, 3 Waters Edge Place, Lexington, KY 40502, (606) 266-8861.

FREE: Computer-language hobbyist gives free advice and technical information about the Algol-sixteen language (for the IBM PC, Zenith Z-100, TI-PC) and other programming languages: BASIC, PL/I, FORTRAN. Send SASE. D. Baer, POB 3020, Farmingdale, NY 11735, (516) 694-5872.

WANTED: Schematics, especially parts lists showing the IC numbers for the Redactron (Burroughs) Console. This is a two-cassette drive and connects to an IBM Selectric II printer (used as a word processor). Will reimburse. Dan Test, POB 9064B, Newark, NJ 07104.

FOR SALE: Televideo 912C terminal: $450. Two SA400 drives with cabinet: $200. Two 19-inch color RGB monitors: $150 each. Will consider any reasonable offers. Rich Pagnusat, 748 Berkley, Elmhurst, IL 60126, (312) 941-0739.

FOR SALE: Three former employees of Digital Group are selling their systems. Send SASE for a list of systems, boards, and parts. Sco Scofield, 1183 Lamar St. #8, Lakewood, CO 80214.

WANTED: Documentation for IMSAI VDP80, especially DIO disk controller or correspondence with anyone familiar with the above. Is there an IMSAI orphans club out there somewhere? May be interested in spare parts or ideas on how to update the VDP80. Grant Hargrave, 8265 ave. de Gaspe, Montreal, Quebec H2P 2J9, Canada.

FOR SALE: Tektronix 7D02 programmable logic/state analyzer, fully implemented with timing option for 48 channels. Includes 7603 mainframe, 7D02 plug-in, general purpose personality module, cabling, and test clips. New condition. Asking $7000, but will negotiate. Michael Balamuth, 300 East Main St., Centerport, NY 11721, (516) 427-7224.

FOR SALE: Excellent condition North Star Horizon with 64K memory and two quad disk drives, Intertube II display, N* floating-point board, and Godbout Spectrum board. Software includes N* DOS, CP/M-2.2, FORTRAN, Statistical Program, and games: $2000 or best acceptable offer. Philip K. Hopke, 706 South Lynn St., Champaign, IL 61820, (217) 352-4282.

FOR SALE: Eight Microvision cartridges (Baseball, Phaser-strike, Alien Raiders, Sea Duel, Cosmic Hunter, Bowling, Connect Four, and Mind Buster). All in good condition. Originally $18 each; will sell for $100 or will trade for TRS-80 Color Computer software and/or hardware. Richard Wasserman, 2795 East 63 St., Brooklyn, NY 11234.

FOR SALE: LA36/LA35 DECwriter II—Interactive Data Communications terminal, standard ASCII keyboard, input/output device. Asking $1000. John L. Chlada, East 210 Route 4, Paramus, NJ 07652, (201) 843-7700.

WANTED: Unwanted or broken printers, computers, and other peripherals. Also, any software for Apple II computer. I'll pay shipping and handling. Charles Dixon, 1450 Jersey Lane, Waterloo, IA 50701.

FOR SALE: IBM Asynchronous Communications adapter for the IBM PC. Supports a variety of RS-232C interfaces and is fully communication programmable. Data rate selectable 50 to 9600 bps. Complete documentation: $100. IBM 64K memory-expansion board: $220. IBM Parallel Printer Adapter, complete documentation: $100. All boards less than a year old and in excellent condition. R. W. Losefsky, 36 Old Milford Lane, West Milford, NJ 07480.

WANTED: Amputated arm from HERO-1. Wade Nelson, 13303 R. Penasquitos Blvd. #A108, San Diego, CA 92129, (619) 692-7228 days and 484-1485 evenings and weekends.

FOR SALE: VIC-20, 16K RAM, super expanded, introduction to BASIC, three games (Gorf, Quest, and Defender on Tri) three VIC books. All in super condition. Thomas Albertson Jr., 3612 Sprucedale Dr., Annandale, VA 22003, (703) 256-9260.

FOR SALE: Complete Netronics ELF II system with 28K RAM, Giant I/O board, Epson printer interface, ASCII keyboard, 44-pin bus adapter board, text display with high-resolution graphics, power supply, and enclosure. Software includes BASIC, text editor, monitor, and dozens of games. Complete documentation, extensive literature. Worth over $1150. George Musser, 60 Broadway Rd., Warren, NJ 07060, (201) 647-1437.

FOR SALE: Commodore 4016 computer with 16K RAM, a built-in 12-inch green screen, and a full-sized keyboard. It contains a new version 4.0 BASIC and is only one year old. In good condition; asking $680. Leon Fan, 4738 C. Main St., Skokie, IL 60076, (312) 679-4007.

FOR SALE: IMSAI PCS-44 64K RAM, 8085 processor, dual 5¼-inch format either 40 or 77 track (360+K each), IMDOS 2.05 with utilities, and manuals, $1500. Jerry Augst, 5233 16th Ave. S, Minneapolis, MN 55417, (612) 726-2699 weekdays.

WANTED: People or clubs interested in joining nationwide hardware/software Computer Buying Club are welcome to join. Monthly newsletter, club catalogs, special services, and news-flash updates. M. Louis Brott, Suite 7502, 1400 Worcester Rd., Framingham, MA 01701.

FOR SALE: TRS-80 Model I 48K, MDX-2 interface, RS-232C, modem, printer port, two Tandon 40 track drives, NEWDOS, FORTRAN, and more. Good condition: $1595. Wendell Hutchings, (303) 733-2439 between 8 and 5.

FOR SALE: Osborne I single-density drives: $1350. TRS-80 Model II 64K with CP/M 2.2: $2750. Model II Expansion Unit with one drive: $750. TRS-80 Line Printer VI: $750. Chelley Hoffman, Box 413, Gates Mills, OH 44040, (216) 729-2808.

FOR SALE: Used wire-wrap tools. Thor 115v industrial gun, uses standard 22- to 32-gauge bits: $60, less bit. OK Hobby-Wrap gun with 30-gauge bit and Ni-cad batteries: $20. 26- to 28-gauge bit for OK gun: $5. Vector Slit-N-Wrap manual tool: $17, spare bit: $8. OK Just-Wrap manual tool: $8. Edsyn Deluxe Soldapullt, anti-static model: $15. Bob Levine, 32 King St., New York, NY 10014, (212) 691-2897.

FOR TRADE: TRS-80 Model III-compatible software to swap: utilities, word processing, games. Send a list, disk or cassette of your better programs and I will promptly return same. I have two drives and can accept nonsystem disks. Cassettes limit two programs. Michael Vernier, POB 3075, Farmington Hills, MI 48018, (313) 661-1205.

FOR SALE: OSI 8K computer system, 6A switching power/supply, RS-232C port, Centronics serial printer, 9-inch GBC black-and-white monitor. All documentation included: $400. Mark Woithe, 62 Coddington Ave., Hopelawn, NJ 08861, (201) 442-5242 evenings.

FOR SALE: NEC PC8001A complete system. Z80 processor, 64K RAM, BASIC in ROM, RGB color monitor, printer, dual DSDD disks, CP/M, Supercalc, dBASEII, Modem7, SELECT, games, and more software. Great development system. Perfect shape, best offer. Richard Beal, POB 44, Aptos, CA 95003, (408) 688-8648.

FOR SALE: Four Shugart 8-inch SA1002 5.33-megabyte hard disk drives, unused: $380 each. Also, Western Digital controller for this drive: $350 each. Herb Merrill, 20 Randy Dr., Taylors, SC 29687, (803) 877-9444.

FOR SALE: Unused software for Commodore VIC-20s with at least 6K RAM. A few of these cassettes and cartridges have been slightly used but are in excellent condition. Send SASE. Ken Payne, 2623 Brocklin Dr., Grayson, GA 30221, (404) 972-3091 after 5 p.m.

FOR SALE: HP-85A microcomputer with built-in high-performance tape drive, printer, and monitor; 16K RAM module (32K total); 82950A direct connect/auto dial modem; HP-IB interface; and ROMS: Advanced Programming, I/O, mass storage, printer/plotter, and matrix. In software: three word-processing programs ($550 retail), telecommunications, games, database program, 30 tapes ($19 retail each), and padded carrying case with dust cover. Current value $4600+; asking $3300 or best offer. Bob Midden, (301) 338-3346.

FOR SALE: New parallel-printer interface by Micro World Electronix, Model MW-302, for the Commodore VIC-20 or 64. Use with all Centronics type printers and plotters. Switch-selectable options include 7- and 8-bit output, ASCII or PET ASCII, and device 4, 5, 6, or 7. Professional Software recommends MW-302 for use with 64 version of Word Pro 3+. List price $119.95; will sell for $80. W. R. Freytag, 1141 Kathryn St., Boalsburg, PA 16827.

WANTED: MPX-16 owner seeks correspondence with other owners or users. David Claxton, RFD Box 449, West Bath, ME 04530, (207) 443-4588.

WANTED: People interested in sharing ideas about Apple III. The possibility exists of forming an international users group. George H. Buch, c/o Buchan, Ravnsborggade 19, Copehagen 2200 N, Denmark.

FOR SALE: Heath H-8 with 8K memory and H-9 video. Presently inoperable. Ideal for one with good electronics background or an electronics hobbyists. Will take best offer. Michael R. Skwark, 2517 Pineway Dr. S, Mobile, AL 36605, (205) 476-0464.

WANTED: Documentation for the Atari Video Computer System. Particularly interested in schematics and instructions to convert the game from NTSC to PAL-N systems. Will cover your shipping and printing costs. Fernando Ubiria, Uruguay 1198 Apt.2, Montevideo, Uruguay, South America.

FOR SALE: Two Shugart SA-400 SSDD disk drives in separate cabinets with power supplies and manual. Asking $325, will pay postage within U.S. S. Jackson, 2272 Covent Gardens Court, Reston, VA 22091, (703) 476-4763.

WANTED: College student/programmer seeking correspondence with owners of TRS-80 Color Computers and Monroe microcomputers to exchange programs and information. Also looking for used disk drives and modems. Lawrence Hall, 94-19 133 St., Richmond Hill, NY 11419.

FOR SALE: Hewlett-Packard 9845A desktop computer complete with 64K RAM (62K available for programs), 80-column monitor, fast thermal printer, two fast tape drives, graphics ROM and high-resolution graphics, modem, 32 user-programmable keys, various software, and other supplies. Mark Brandon, 2720 Fernbrook Lane, Minneapolis, MN 55441, (612) 559-9361 days.

FOR SALE: Hewlett-Packard HP-85 professional microcomputer with 32K main memory. Two software packs include Visicalc Plus and Financial Decisions. Less than one year old. Asking $2200. Dean Nolte, 11625 Applewood Knolls Dr., Lakewood, CO 80215, (303) 233-7971.

FOR SALE: Teletype Model ASR-35 with 20-mA current-loop interface and complete manuals: $250. Tim Martin, 1900 Noriega St., San Francisco, CA 94122, (415) 665-6656.

FOR SALE: DEC LA-34 DECwriter IV printer/terminal with 7 by 9 dot-matrix printer with full remote-terminal capabilities; expanded and compressed print; 7 choices of vertical pitch; 7 foreign-language character sets; built-in diagnostics. All features are software or keyboard selectable. Has full 67-key typewriter keyboard. Accepts any paper size up to 14 inches; friction or tractor feed; used only 2 months in light, noncommercial environment: $1000. Steve Otenti, 13 Park St., Hudson, MA 01749, (617) 562-7150.

WANTED: Contact with users of Morrow Designs' Micro Decision in Los Angeles area. Let's get together for sharing ideas and mutual help. Send SASE and I'll coordinate arrangements. E. R. Paquin, 104 West Wistaria, Arcadia, CA 91006, (213) 447-6541.

UNCLASSIFIED POLICY: Readers who have computer equipment to buy, sell, or trade or who are requesting or giving advice may send a notice to BYTE for inclusion in the Unclassified Ads section. To be considered for publication, an advertisement must be noncommercial (individuals or bona fide computer clubs only), typed double-spaced on plain white paper, contain 75 words or fewer, and include complete name and address. This service is free of charge; notices are printed once only as space permits. Your confirmation of placement is appearance in an issue of BYTE as we engage in no correspondence. Please allow at least three months for your ad to appear. Send your notices to Unclassified Ads, BYTE/McGraw-Hill, POB 372, Hancock, NH 03449.

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Real-Time Builders Vote for Ciarcia

The July BOMB tally reveals Steve Ciarcia to be first in the winner's circle with his article, "Build the RTC-4 Real-Time Controller." The author of the Circuit Cellar takes the $100 prize. Second place in the winner's circle is Jerry Pournelle's User's Column entitled "Interstellar Drives, Osborne Accessories, DEDICATE/32, and Death Valley." The doctor will be awarded $50. And Mark Dahmke's article, "CP/M Plus," takes third place in our monthly countdown.

Correspondence

Address all editorial correspondence to the editor at BYTE, POB 372, Hancock, NH 03449. Unacceptable manuscripts will be returned if accompanied by sufficient first-class postage. Not responsible for lost manuscripts or photos. Opinions expressed by the authors are not necessarily those of BYTE.

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